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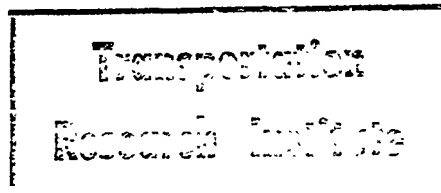
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SEMI-AUTOMATIC
BEAM-LINE FEASIBILITY STUDY

U. S. Department of Transportation
Maritime Administration

in cooperation with
Avondale Shipyards: New Orleans Louisiana



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This work is dedicated to the memory of
Raymond C. (Pookie) Bertin: A sailor and
2 Navy man from New Orleans, Louisiana .

TABLE OF CONTENTS

Foreword

Executive Summary

| | |
|--|---------|
| Section One: Feasibility Guidelines | Page 1 |
| 1.1 Technical Approach | Page 1 |
| 1.2 General Procedures | Page 2 |
| 1.3 Research Findings | Page 2 |
| 1.4 Feasibility Determinants | Page 3 |
| 1.5 Feasibility Perspectives | Page 4 |
| 1.5.1 Work Station Feasibility | Page 4 |
| 1.5.2 Measuring System Feasibility | Page 5 |
| 1.5.3 Marking (Part Identification) Feasibility | Page 5 |
| 1.5.4 Cutting & Edge Preparation Feasibility | Page 5 |
| 1.5.5 Surface Preparation & Coating Feasibility | Page 6 |
| 1.5.6 Final Product: Temporary Storage Feasibility | Page 6 |
| 1.5.7 Transportation & Handling Feasibility | Page 6 |
| 1.5.8 Computer Software Feasibility | Page 6 |
| 1.6 Anticipated Benefits | Page 7 |
| Section Two: Functional Description | Page 8 |
| 2.1 introductory Note | Page 8 |
| 2.2 Core Concept | Page 8 |
| 2.3 Principal Features | Page 9 |
| 2.4 General Conditions | Page 10 |
| 2.4.1 Structural Components | Page 10 |
| 2.4.2 Cutting Requirements | Page 11 |
| 2.4.3 Marking Requirements | Page 11 |
| 2.4.4 Cleaning & Priming Requirements | Page 11 |
| 2.4.5 System Capacity | Page 12 |
| 2.4.6 Daily Production Rate | Page 12 |
| 2.4.7 Number of Workers | Page 12 |
| 2.5 Time Comparisons | Page 13 |

| | |
|---|-----------|
| 2.6 SABL: New-System Summary | Page 14 |
| 2.6.1 Equipment Requirements | Page 17 |
| 2.7 SABL: New-System Sketches | Page 17 A |
| Plan View of Beam Line | Foldout |
| Elevation View: Sec. A-A | Foldout |
| Shape Manipulation Processes | Foldout |
| Production Flow and Production Rate | Foldout |
| 2.8 Equipment Specifications | Page 18 |
| Infeed Transfer Table | Page 18 |
| Infeed Roller Conveyor | Page 19 |
| Preheater | Page 19 |
| Shotblast Machine | Page 20 |
| Blow-Off Plant | Page 21 |
| Automatic Exhaust Plant | Page 21 |
| Airless Automatic Paint Spray | Page 22 |
| Carrying Chain Transport | Page 22 |
| Outfeed Roller Conveyor | Page 23 |
| Transfer Table | Page 24 |
| Main Roller Conveyor | Page 24 |
| Transfer System | Page 25 |
| Burning Table Conveyors | Page 25 |
| Burning Table | Page 25 |
| CNC Burning Machines | Page 26 |
| Pal let Wagon | Page 28 |
| Outfeed Chain Conveyor | Page 28 |
| Band Saw | Page 29 |
| Outfeed Roller Conveyor | Page 30 |
| Rack for Shapes | Page 30 |
| Section Three: Computer Software Requirements | Page 31 |
| 3.1 Introductory Note | Page 31 |
| 3.2 Computer-Aided Drawing System (CAD) | Page 32 |
| 3.3 Beam Line Management System (BLMS) | Page 32 |
| 3.4 Computer Numerical Control (CNC) | Page 33 |
| 3.5 Data Requirements | Page 33 |
| 3.6 Standard Configurations | Page 33 |
| Basic Angle End Cut Configurations | Page 34 |
| Basic Tee End Cut Configurations | Page 35 |
| Basic Flat Bar End Cut Configurations | Page 36 |
| Typical Flat Bar Details | Page 37 |
| Water Stops | Page 38 |
| Typical CT & CL for 6x3 1/2 Angle | Page 39 |
| Rationalization: Angle Cut-Out Nomenclature | Page 40 |
| Standard Edge Preparation | Page 41 |
| Section Four: Advanced Research and Development | Page 42 |
| 4.1 Introductory Note | Page 42 |
| 4.2 Machine-Computer interface | Page 43 |
| 4.3 Robotics Use | Page 43 |
| 4.4 Accuracy Control | Page 43 |
| 4.5 Automatic Unload: Small Parts | Page 43 |
| Section Five: Project Resources | Page 44 |
| 5.1 Shipyard Survey | Page 44 |
| 5.2 Beam-Line Survey | Page 45 |
| 5.3 Beam-Line Equipment Manufacturers Survey | Page 45 |

FOREWORD

A Semi-Automatic Beam Line system is reported on here. It offers cost-saving features and practical benefits to shipyards. Increased productivity is the goal and purpose of the Semi-Automatic Beam Line (or SABL) system. The plan is, in part, a response to an industry priority set forth by the Merchant Marine Act of 1970: *to improve shipbuilding productivity and reduce shipbuilding costs while maintaining requisite high standards for critical processes and operations.*

It is anticipated that the results of this preliminary examination will demonstrate to the shipbuilding industry, through the Society of Naval Architects and Marine Engineers (S NAME) Facilities Panel SP-1, the Maritime Administration, and the U.S. Navy, that the development and implementation of the Semi-Automatic Beam Line plan as recommended fulfills all criteria for cooperative program continuation as defined by the National Shipbuilding Research Program.

The importance of this project would be even further emphasized by a full roster of all who gave time and knowledge to aid project research and planning. Among numerous individuals to whom credit and thanks are due, those whose names follow warrant particular acknowledgement for both significant contributions, and ongoing involvement with this project's concept, planning, progress: and positive results.

Executive administration and supervision were provided by O. H. Gatlin, Vice President, Corporate Plant Engineering and Maintenance, Avondale Shipyards, Incorporated; with R. A. Price, MarAd Research & Development Program Manager, Avondale Shipyards Inc.

A Special Advisory Group for Technical Application consisted of E. Pedersen, President, Total Transportation Systems, Incorporated; with F. E- McConnell, Vice President, Total Transportation Systems, Incorporated; and C. B. Jensen, President, LERCO, Incorporated.

Advisory committee responsibilities were fulfilled by the following officers of Avondale Shipyards, Inc.: A. L. Bossier, President; H. F. Aronald, Vice President; E. Blanchard, Group Vice President; G. Blanchard, Vice President; D. Clark, Group Vice President; T. Doussan, Vice President; and W. Harmeyer, Group Vice President; together with J. Garvey and R. Schaffran, Office of Advanced Shipbuilding Development, Maritime Administration, U. S. Department of Transportation, and W. Holden, Naval Material Command Headquarters, United States Navy.

Special acknowledgement is also extended to the many domestic and foreign company representatives aiding the research team with on-site field tours and technical data.

EXECUTIVE SUMMARY

OBJECTIVE

The critical goal of this project was the design of a semi-automatic system of beam fabrication: a system to reduce today's record-high levels of labor costs; to revise usual materials-handling methods to upgrade flow efficiency; and bring about streamlined space requirements for both operations and storage areas. Our goal was a Semi-Automatic Beam Line which would bring clear positive advances to current shipbuilding practice: and enhance today's shipbuilding productivity.

APPROACH

Our technical approach to this project has fulfilled the stated objectives of the National Shipbuilding Research Program as established by the Merchant Marine Act of 1970. Our project determination at its conclusions: that the concept of a Semi-Automatic Beam Line is not merely a possible productivity tool for shipyards, sometime in the future! It can, in fact, be implemented today! It can offer tangible benefits. it is practical. It is workable. It is feasible.

CRITERIA

The following list of functional criteria together describe the Semi -Automatic Beam Line (SABL). Its features can be considered individually; as a system in total; or as " components" capable of varying use-combinations. Flexibility, then, is offered, among other advantages: since the system can be implemented or set up incrementally.

FUNCTIONS

Conveying: An automatic conveying system moving work pieces between work stations is to be equipped with an automatic unloading device at each station as well as materials-holding areas for each machine.

Measuring: Measurement of beams for cutting to length, locating holes and other layout requirements is to be automatically accomplished.

Marking: Each completed piece is to be marked with its part number as identified in the procedural drawings.

Cutting/Edge Prep: CNC control of cutting and edge preparation process stages is to be implemented. This function is extremely important.

Blasting/Coating: Blasting and coating should be carried out according to a semi-automatic system: cost savings in double handling can be gained.

Storage: Fabricated beams are to be palletized and stored in a racking order, according to scheduled use, until required.

Transportation/Handling: Necessary equipment must allow for selection, loadout, and delivery of fabricated beams to installation site.

Computer Software: Support software to be developed for the new beam fabrication shop will have capability of preparing detail drawings; as the drawings are being prepared, the program should provide preparation of bills of material; shop production schedules; materials-flow routing; cutting lists; assembly marks. The interface for CNC capability must be included.

COSTS

The new beam line is put to work in real operation by an expenditure from \$2,000,000 to \$3,500,000, depending upon facility. Accurately, however, this capital outlay should be seen as an investment; not a 'cost.' Its aim is to recover expenditure, then move into a "benefits zone, " where efficiency and productivity begin to translate into profits! Consider, for example, that the semi-automatic beam line is designed for production of 1200 fabricated beams daily, with correspondingly reduced skilled-labor manpower needs. Each year at the facility studied, beam fabrication required 92,227 manhours. Our data shows that the semi-automatic system can reduce that figure by approximately 72,227 manhours, leaving 20,000 manhours projected - a substantial reduction. For managements considering this new system, our study can offer at least these two expectations: 1) an investment return of approximately 54.95% per year, again depending upon facility, and 2) a beam line system that is both cost-effective and "future capable" of adjusting to meet increased demands.

Index to SECTION ONE, which follows:

- 1.1 Technical Approach**
- 1.2 General Procedures**
- 1.3 Research Findings**
- 1.4 Feasibility Determinants**
- 1.s Feasibility Perspectives**
- 1.6 Anticipated Benefits**

SECTION ONE

SEMI - AUTOMATIC BEAM LINE SYSTEM: FEASIBILITY GUIDELINES

1.1 Technical Approach

The intent of this study: To examine the feasibility of a new beam-line plan for shipyards, designed to incorporate current state-of-the-art manufacturing processes which offer both technological innovation and high functional reliability. Broadly overviewed, our technical approach covered these research states:

Layout facility is diagramed to show work stations, equipment locations, conveying-systems routing, and other information.

Functional flow processes are identified, including shape manipulation and burning processes.

A preliminary equipment list is drawn up.

A preliminary phasing plan for equipment installation is drawn up.

Interface with the ship producibility program is maintained.

New-system cost estimates for the SABL plan are prepared.

Present system is compared to the SABL plan in a structured way.

A Phase-1 completion report (Note: this *document*) is prepared and forwarded to MarAd and the Ship Production Committee for review.

1.2 General Procedures

- ° To discover current state-of-the-art, our methods included interviews with knowledgeable individuals in shipbuilding; other industries, foreign and domestic; review of relevant literature; required correspondence.
- ° To identify potential participants, we began with recommendations of various industry and professional contacts. A first screening factor was significant prior experience in conducting a disciplined Research and Development effort with well-defined objectives ...” Later screenings examined a candidate’s probable continuing interest in the U. S. ship - building industry.
- ° Since it was necessary to determine priorities within this project, we did so based on the likelihood of increased productivity, or economic gain.
- ° Proposal submissions were invited from various manufacturing and consulting firms as well as from within the shipbuilding industry itself, and from other businesses that share interests and concerns with shipbuilders. Responses to inquiries were tabulated, by group, prior to identification of candidates judged to be best qualified; and/or most promising; as project participants.
- ° In evaluating proposals, our previous criterion continued to be prominent: primary attention was given a proposal’s potential for economic benefit. Research data was periodically evaluated, and reports on project data disseminated on an ongoing basis. Some interim reports, delivered orally, gave informal progress data; these informal reports were supplemented at intervals by more formal, written information reports and summaries.
- ° Presently, our project data has been summarized; and oral and written reports of project results variously distributed. Additionally: areas related to this project, and offering potential benefit to industry goals, are being evaluated.

1.3 Research Findings

- ° There exists no Semi-Automatic Beam Line (SABL) that meets all criteria of this project: existing SABL systems are “partial systems” limited as to machine-control capability.
- ° Still: Present SABL systems are relatively efficient: they effect cost savings despite their limiting factors.
- ° Many resources (equipment, machinery, devices) to implement SABL are available on world markets. The task of modifying others remains; along with the need to develop prototype equipment in still other instances.

1.4 Feasibility Determinants

Feasibility determinants of the Semi-Automatic Beam Line (SABL) system investigated by this project include:

PROCESS. Determine the design of a cost-effective method of splitting and/or deflanging structural; cutting all shapes, holes, end shapes on beams, angles, channels, etc.

CRITERIA. The facility must be designed to handle 1/2 x 1/2 bar angles through 36.42" x 12.12" x 194 lbs. per ft. structural, maintaining accuracy of .040 -

SPECIFICATIONS. Following is a list of fundamental features that are needed as part of an efficient, highly productive SABL facility:

- Automatic feed system for sorting and grouping raw materials with push-button, select controls.
- Automatic conveying system for moving the work piece from one work station to another station.
- Automatic measuring system.
- Automatic marking system.
- Semi-automatic loaded cutting machines.
- Manipulator fixtures integrated with various types of cutting machines for processing the work piece.
- Semi-Automatic surface preparation system.
- Automatic or semi-automatic control of temporary storage and palletizing procedures and environments.
- Transport system for moving palletized pieces from temporary storage to installation site.
- Software package to support the new SABL system.

FEASIBILITY DETERMINANTS: REVIEW AND ASSESSMENT. It was determined that the criteria are sound. The criteria as outlined can mean improved productivity for the industry (though there would be some expected differences between major shipyards, and smaller facilities, in implementing components of the new system). Presently: a number of items of equipment required by project criteria are available on today's world markets and can be implemented as purchased. Other items can be obtained; but require some modification to be an operating part of the production plan. Still other items required by project criteria do not exist as commodities available on today's markets. While their feasibility can be determined and projected, these items must be developed and tested before they can be realistically seen as production equipment for the SABL system.

1.5 Feasibility Perspectives

In research of this type, it is important to remember that “The whole is the sum of its parts.” To be accurate in determining whether an overall system is feasible, it is necessary to examine each of that system’s critical parts or components. That is why, in the next parts of this section, the emerging “general picture” of SABL feasibility is broken down into eight “closeups:” feasibility evaluations or observations closely focus on seven processes within the envisioned SAL system; and one underlying “support structure” (computer software) to aid the new or revised processes in actual operation.

1.5.1 Work Station Feasibility

CRITERIA. Work stations should be connected by a conveying system that will automatically move the work piece from one work station to another. This automatic conveying system must be developed. Each work station also requires an automatic loading/unloading device: and is to be equipped with appropriate controls to select the desired quantity of work pieces to be processed.

RESEARCH CONCLUSIONS. A conveyor suitable in design for transporting the work piece is available from domestic and foreign suppliers. (Some special loading and unloading devices must be designed to feed equipment not previously automated, however.) Automatic and/or push-button controls are available for purchase as a stock item. The engineering requirements for proper sequencing and phasing, however, must be developed to suit the particular system being installed. It is possible to purchase the conveying equipment; loading and unloading devices; and the controls AS A PACKAGE. The user must determine, however, the type and quantity of conveyor, loading/unloading devices; and controls required. This is a natural process during facility design and layout.

FEASIBILITY. Our research strongly supports the feasibility of the handling system here outlined and recommended. Some of the handling equipment and devices can be purchased: the balance must be designed. Prototypes. must be developed and tested.

1.5.2 Measuring System Feasibility

CRITERIA. Measuring-system capability is to include automatic measuring of the work piece for cutting to length, locating holes, other layout factors.

RESEARCH CONCLUSIONS. The capabilities of measuring and cutting to length are available and installed on all cutting machines seen at automatic beam-fabrication facilities. Measuring and locating hole cuts is a manual process at most facilities visited. Measuring and layout of beam end cut and shapes are manual operations in most facilities visited.

FEASIBILITY. Automatic measuring systems can be purchased for cutting machines and can be built into cutting machines: it is also possible that other layout requirements can be accomplished automatically.

1.5.3 Marking (Part Identification) Feasibility

CRITERIA. The SABL system marking process should have the capability of automatically marking each completed piece with its part number as specified in production drawings. Structurally, this marking device should be appropriate as an attachment to the cutting machine.

RESEARCH CONCLUSIONS. Part identification marking is a manual work operation in domestic and foreign shipyards.

FEASIBILITY. A prototype marking device must be designed and tested.

1.5.4 Cutting and Edge Preparation Feasibility

CRITERIA. Various cutting processes, appropriate to different types of work pieces, must be pre-determined. Particular attention should be given to cutting speeds and quality. A pushbutton-controlled automatic loading and unloading device should be in use at each cutting machine. It should both move usable work pieces to next work station, and dispense scrap for removal.

RESEARCH CONCLUSIONS. It was determined that the cutting process is the most critical process in the automated system. The point at which the work piece is cut is usually a fit-and-weld joint done later on during production.

FEASIBILITY. Edge preparation can be accomplished along with cutting; the bevel can be done during the cutting operation. The availability of plasma/gas cutting machines, through domestic and foreign suppliers, makes possible those processes, as well as automatic splitting and deflanging; end cuts, shapes and holes. A prototype machine, however, must be designed and tested for criteria suitability.

1.5.5 Surface Preparation and Coating Feasibility

CRITERIA. The development of a semi-automatic surface preparation system for beams, angles, channels and flat bar before the fabrication process is complete. A semi-automatic coating system for the types of pieces mentioned should also be developed: and the coating process accomplished at a similar process point, before completed fabrication.

RESEARCH CONCLUSIONS Effective surface-preparation equipment, usable within the SABL plan design, is available from both domestic and foreign suppliers: coating systems equipment is similarly available.

FEASIBILITY. The availability of materials to accomplish "semi-automatic" cleaning and coating establishes the feasibility of their use.

1.5.6 Final Product: Temporary Storage Feasibility

CRITERIA. The design of a plan for completed work pieces to be palletized, stored in a racking system (in scheduled-use order) to await installation need.

RESEARCH CONCLUSIONS. Temporary storage areas have been seen at most of the facilities visited during this study: most of the required equipment is available and can be purchased.

Feasibility. The final-product temporary storage plan outlined is feasible.

1.5.7 Transportation and Handling Feasibility

CRITERIA. The development of cost-effective transportation and handling equipment for transporting completed parts to the installation site (selection through delivery).

RESEARCH CONCLUSIONS. Equipment required for these procedures is available. However, specific equipment selections should consider design and layout features of a particular storage environment.

Feasibility. Our research has determined the feasibility of these procedures.

1.5.8 Computer Software Feasibility

CRITERIA. Development of support software for various phases of SABL. The right package would have detail drawing capability; concurrent selection bills of material; shop production schedules; materials-flow routing; cutting lists; assembly marking; and loading, disposition, delivery schedules. The interface providing CNC capability is a necessary, important feature!

RESEARCH CONCLUSIONS. Software packages are obtainable; but the interface appropriate for the SABL system has special requirements to be met.

FEASIBILITY. Software systems meeting criteria are feasible: development and testing are necessary, however!

1.6 Anticipated Benefits

The major benefits anticipated to result from the development of this project fall into the following areas:

1. Handling
2. Burning
3. Splitting, Deflanging
4. Punching
5. Surface Prep and Coating.

Using 1978-79 base data, we have established the percentage savings anticipated for each of these procedural areas:

| <u>Specific Labor Procedure</u> | <u>Anticipated SABL System Savings</u> |
|---------------------------------|--|
| 1. Handling | 40% |
| 2. Burning | 82% |
| 3. Splitting, Deflanging | 41% |
| 4. Punching | 100% |
| 5. Surface Prep and Coating | 82% |

Using the given percentage projections as a base, it is conceivable that Avondale Shipyards, Inc. could accomplish production of fabricated beams for shipyard use at a "cost" of only 20,000 manhours within the Semi-Automatic Beam Line fabrication plan. The new figure of 20,000 manhours compares to 92,227 manhours expended under the present system; and so represents a substantial reduction, or savings, of approximately 78.3%.

Index to SECTION TWO, which follows:

2.1 Introductory Note

2.2 Core Concept

2.3 Principal Features

2.4 General Conditions

2.5 Time Comparisons

2.6 SABL: System Summary

2.7 SABL: System Sketches

2.8 Equipment Specifications

SECTION TWO

SEMI-AUTOMATIC BEAM LINE PLAN: A FUNCTIONAL DESCRIPTION

2.1 introductory Note

This section takes a conceptual approach to the design of the proposed Semi-Automatic Beam Line fabrication facility. Included are machine concept drawings and specifications which we consider essential.

Avondale Shipyards' existing methods and processes were used as base during the development planning required to produce the facility layout, process sequence, production flow, and production rate.

2.2 Core Concept

The basic premise underlying this proposed SABL system may be seen as the elevation of "automation" from mere production technique to central production concept. The proposed system is to be an integrated and automated processing line. Emphasis has been placed on the automation of such processes as critical cutting and handling systems. Among the observed productivity y-serving effects of automation, we can count not only savings in manhours but also standardization of fabrication methods; improved fabrication precision; centralized control of scheduling and some materials handling; and more.

2.3 Principal Features

The principal features of equipment to be installed as part of the SABL facility are the following:

MECHANICAL HANDLING. Through judicious selection of material handling components, hand rigging throughout the beam fabrication process has been eliminated. The elimination of multiple handling of beams is perhaps the greatest savings contributor in the beam-fabrication line.

ADEQUATE BUFFERING. Considering a throughput of approximately 35,000 beams per year, accurate calculation of individual beam fabrication time becomes unwieldy if not impractical. Buffering between production operations, including initial infeed and final discharge, is essential to balance the line to realize the inherent productivity of the concept.

BEAM ALIGNMENT. Recovering the considerable time presently lost in setting up the beams for marking and burning requires that a means of rapid and accurate alignment of beams to the burning machine axis be provided. The burning tables, operating in conjunction with cross-transfer, in effect form a sub-system to fulfill this requirement.

Flexibility. If the complete range of beam configurations, sizes and operations (profile cutting in two planes; marking; splitting; deflanging) cannot be handled on the beam line, then potential savings begin to evaporate. We have found that a standard burning machine cannot perform all operations over the predicted size range and are advising that a modified machine, with the following capabilities, be considered:

Profile cut capability (any configuration) in either the horizontal (web) or vertical plane (flange);
Multi-beam, single-stroke straight end cut capability (method here involving a vertical torch. by programming a percentage speed reduction, and a switch to high preheat at beam flange locations.)

These are only examples: Additional features such as: automatic and semi-automatic controls (where desirable); palletizing capability for small parts; band-saw option; and quiet conveyor and transfer operations are among others to be noted, later in this section.

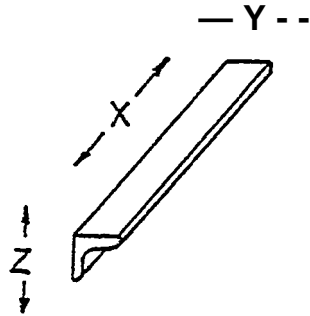
2.4 General Conditions

The Semi-Automatic Beam Line system is made operational given the listed conditions which follow, Sec. 2.4.1 to 2.4.7.

2.4.1 Structural Components [By Section; Size; and Stock Length]

| Type | Minimum Section | Maximum Section | Stock Length |
|-------------------------------------|-----------------------|--|--------------|
| Bar Angles | 1/2" X 1/2" X 0.38# | 2 1/2" x 2 1/2" x 7.70# | 20' |
| Ear Channels | 3/4" X 5/16" X 0.50# | 1 1/4" x 1/2" x 1.01# | 20' |
| L Shapes Structural Angles | 3" x 2" x 3.10# | 8" X 8" X 56.9# 9" X 4" X 40.8# | 40' |
| C Shapes Structural Channels | 3" x 1.410" x 4.10# | 15" X 3.716" X 50.0# | 40' |
| MC Shapes Car & Ship Channels | 3" X 1.928" X 7.1# | 18" X 4.100 X 58.0# | 40' |
| S Shapes Structural I-Beams | 4" X 2.663" X 7.7# | 24" X 8.048" X 120.0# | 40' |
| W Shapes: Structural Wide Flange | 4-16" X 4-06" X 13.0# | 27.31 X 14.09 X 177.0# 36.48 X 12.12 X 194-0# | 40' |
| Flat Bar | 1" x 3/8" | 7 1/2" x 1.5" | 40' |
| Built-Up Tees | | 24" X 7 1/2" X 1.5" | 40' |
| Built-Up Angles | | 24" X 7 1/2" X 1.5" | 40' |

2.4.2 Cutting Requirements



Straight Cuts

- “ End cuts in Y direction
- ° End cuts in Z direction
- ° Splitting and deflanging in X direction

° Profile cutting in X-Y plane

° Profile cutting in X-Z plane

Single Bevel Cuts

° End cuts in Y direction

° End cuts in Z direction

2.4.3 Marking Requirements

“ Punch marking *or* line marking in X-Y plane

° Imprinting capability up to 26 alpha/numeric characters in X-Y plane

2.4.4 Cleaning and Priming Requirements

° In-line equipment capable of shotblasting and priming with inorganic Zn to 1 mil. dry film thickness

2.4.5 System Capacity

System Capacity: Up to 35,000 incoming pieces of material annually

| | |
|---|---------------|
| “ Bar-Size Angles and Channels, 20 ‘ length | 8,000 |
| °Structural Size Shapes L, C, MC, S, W; Flat Bar 40’ length (*) | 24,000 |
| °Built-Up Tees and Angles, 40’ length | 3,000 |
| Total | 35,000 |

(‘) Of 24,000 Structural Size Shapes : 5000
M,C and W shapes will require de flanging
or splitting as well as normal treatments.

2.4.6 Daily Production Rate

| <u>Material Type:</u> | <u>Stock Pcs/Day:</u> | <u>Completed Pcs/Day:</u> |
|----------------------------------|-----------------------|---------------------------|
| °Structural L, C, MC, S, W | 96 | 848 |
| “ Bar Size: Channel, Angle, Flat | 32 | 256 |
| °Built-Up Tees and Angles | 12 | 96 |
| Total | 140 (“) | 1,200 (*) |

Working Hours Per Shift: 8

Number Shifts Per Day: 2

(•) Figures above are estimated. Also refer
to Production Flow and Production Rate
System Sketch, Section 2.7.

2.4.7 Number of Workers

Estimated number of workers needed to operate a Semi-Automatic Beam Line:

| <u>Function</u> | <u># Needed</u> <u>1st Shift</u> | <u># Needed</u> <u>2nd Shift</u> | <u>Total</u> |
|---|-------------------------------------|-------------------------------------|--------------|
| ° Cleaning, Painting | 1 | 0 | 1 |
| ° Saw Cutting | 1 | 0 | 1 |
| ° Burning Machine (1) | 1 | 1 | 2 |
| ° Burning Machine (2) | 1 | 1 | 2 |
| ° Off -loading, Palletizing and Supervision | 2 | 2 | 4 |
| Total | 6 | 4 | 10 |

2.5 Time Comparisons

[Standard Beam Fabricating Methods v. Semi-Automatic Beam-Line Fabrication System]

The following columns compare five labor functions involved in beam fabricating processes. The existing operation, (Standard System), was time studied at beam fabricating areas of Avondale Shipyards, Inc., while the proposed operation (SABL System) is an actual/anticipated cycle time utilizing automation to streamline tasks. The figures point out the significant savings which can be gained by automating beam fabrication processes.

| | H o u r s E x p e n d e d | |
|-----------------------|-----------------------------|-------------|
| | Standard System | SABL System |
| Handling | 10,000 | 6,000 |
| Burning | 45,583 | 8,000 |
| Splitting /Deflanging | 6,758 | 4,000 |
| Punching | 18,950 | 0 |
| Blasting/Painting | 10,926 | 2,000 |
| Totals | 92,227 | 20,000 |

2.6 SABL: New -System Summary

Summarized below is the step-by-step work station methodology for processing and handling beams according to the proposed new Semi-Automatic Beam Line system. For numerical reference throughout this summary, refer to the first large System Sketch in Section 2.7 [next following section]. This sketch is called PLAN VIEW OF BEAM LINE.

Beams are brought to the infeed area in bundles or singly. The Infeed Transfer Table (Mark 1) is used to sort the beams into packages up to 5' wide before processing.

The transfer table works in semi-automatic mode, or manually. When a load is ready to be processed, the transfer table, in the semi-automatic mode, transfers the load onto the Infeed Roller Conveyor (Mark 2).

Beams are processed through the surface treatment area at 3-4 FPM, resulting in a shotblast quality of Sa 2.5.

The Preheater (Mark 3) is used to raise the temperature of the beams and remove water from the material.

The Shotblast Machine (Mark 4) with abrasive return hopper, bucket elevator, and cleaning system, blasts the beams to near-white metal.

The Blow-off plant (Mark 5) removes spent shot from the beams.

The Paint Sprayer (Mark 7) applies 1 mil. dry film primer to the beams.

Each of these units will start automatically when beams approach the unit; and stop when the beams have passed. Additionally, paint sprayer "senses" and adjusts to the width of the beam bundle to reduce overspray.

Positioned next to the line is an Automatic Exhaust Plant (Mark 6) which collects and filters the exhaust from the shotblast machine.

All controls are grouped in a single console so that the surface treatment line is one-man operable.

After painting, the beams are transported on the Carrying Chain Conveyor (Mark 8), basically a slatted chain designed to eliminate relative movement between the beams and the conveyor. Elimination of relative movement is very important in the first four to six minutes after spraying in order not to damage the paint film.

After the chain conveyor, the Outfeed Roiler Conveyor (Mark 9) transports the load to the Transfer Table (Mark 10).

Discharge from the outfeed roller conveyor can be accomplished either semi-automatically or manually. The transfer table acts as a buffer zone between the surface treatment area and the burning and band-saw areas.

Infeed to the burning area is by means of the transfer table and the Main Roller Conveyor (Mark 11). These movements are normally controlled by the burning machine operators.

Infeed to the Burning Machines (Mark 15) is accomplished by the Transfer System (Mark 12) opposite Burning Tables "A" and "C" (Mark 14) through an additional buffer zone.

From the infeed buffer zone a number of beams are picked up with the transfer system and positioned onto either of the alternate burning tables ("All" or "B", "C" or "D". The Burning Table Conveyors (Mark 13) are used to assist in positioning as required-

After locating the beams on the table, clamps are activated, thereby holding the beams in position for burning.

The burning machine operates along either of the alternate tables- In this way, operators may load and unload one table while burning on the other.

Completed shapes are routed via the burning table conveyor and transfer system opposite burning tables "B" and "D" to the main roller conveyor. Part of the area served by this transfer acts as an outfeed buffer zone.

After splitting or deflanging, all deflanged beams and half the split beams will be improperly oriented for further marking and burning. The burning machines and burning tables are placed so that beam flanges must face in-board. The mirror-image layout of the burning area allows transfer of split or deflanged beams across the burning area to the opposite-handed burning machine. Beam orientation is thereby corrected.

Outfeed to the discharge area on the main roller conveyor is automatic.

When the load reaches the discharge area, the conveyor automatically stops: the Outfeed Chain Conveyor (Mark 17) indexes the load off the roller conveyor approximately one load-width. A detector stops the outfeed chain conveyor when the conveyor is full. Completed beams are unloaded.

Outfeed from the burning machines as described is for lengths greater than 7'

Shorter lengths are loaded onto a Pallet Wagon (Mark 16). This runs on a track in the operator gangway between the burning machine track and burning tables. For discharge, the wagon runs to the discharge area and automatically unloads the pallet onto fixed-load stands. (Pallets are later removed by crane or fork-lift trucks.)

An empty pallet is placed on the wagon returned to the burning machine.

For the Band-Saw (Mark 18), infeed starts in the area of the Transfer Table (Mark 10). Buffer zones are located on each side of the main roller conveyor. A package of shapes, or a single one, is picked up by the transfer table from the nearest buffer zone and positioned on the roller conveyor by the band-saw operator. The main roller conveyor transfers the load (20' long Bar Channels or Angles) up to the saw, where the load is stopped automatically. In this position, the operator may bundle the profiles for the cutting process.

The band-saw is a standard saw with clamping devices; hydraulic tilting; and length gauge with electronic digital readout. Discharge for shapes less than 10' may be accomplished at the end of the Outfeed Conveyor (Mark 19) by a powered ejector. A Rack (Mark 20) for collecting the shapes is positioned opposite the ejector. From there, an overhead crane or fork-lift truck collects the finished shapes. Longer shapes will be discharged along the main roller conveyor as from the burning machines. This discharge cycle is automatic.

2.6.1 Equipment Requirements

This list of required equipment should be a useful adjunct to the New-System Summary just outlined. Additionally: these items of needed equipment, here listed by type, are further detailed in Section 2.8, Equipment Specifications.

MATERIAL HANDLING EQUIPMENT

| <u>Item:</u> | <u>Mark #:</u> |
|-------------------------|----------------|
| Infeed Transfer Table | 1 |
| Infeed Roller Conveyor | 2 |
| Outfeed Roller Conveyor | 9 |
| Transfer Table | 10 |
| Main Roller Conveyor | 11 |
| Transfer Systems | 12 |
| Burning Table Conveyors | 13 |
| Burning Tables | 14 |
| Pallet Wagons | 16 |
| Outfeed Chain Conveyor | 17 |
| Rack for Shapes | 20 |

SURFACE TREATMENT EQUIPMENT

| <u>Item:</u> | <u>Mark #:</u> |
|-------------------------|----------------|
| Preheater | 3 |
| Shotblast Machine | 4 |
| Blow-off Plant | 5 |
| Automatic Exhaust Plant | 6 |
| Paint Sprayer | 7 |
| Carrying Chain Conveyor | 8 |

BAND-SAW EQUIPMENT

| <u>Item:</u> | <u>Mark #:</u> |
|------------------------------------|----------------|
| Band-Saw | 18 |
| Outfeed Conveyor with Length Gauge | 19 |

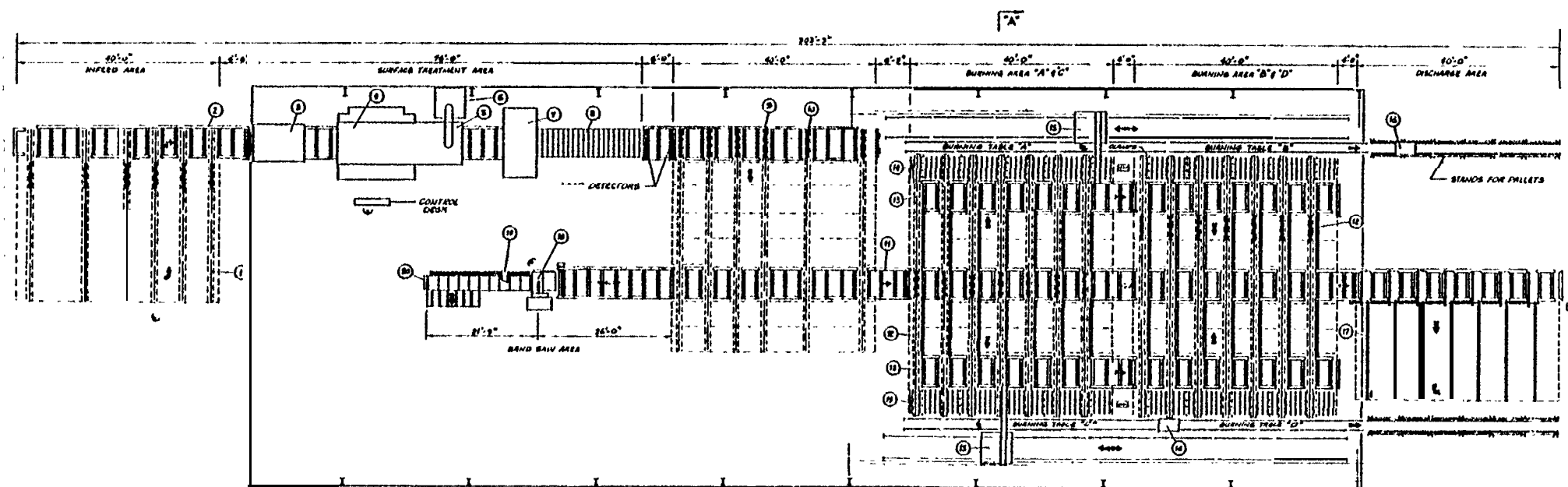
BURNING MACHINES

Mark 15

2.7 SABL: System Sketches

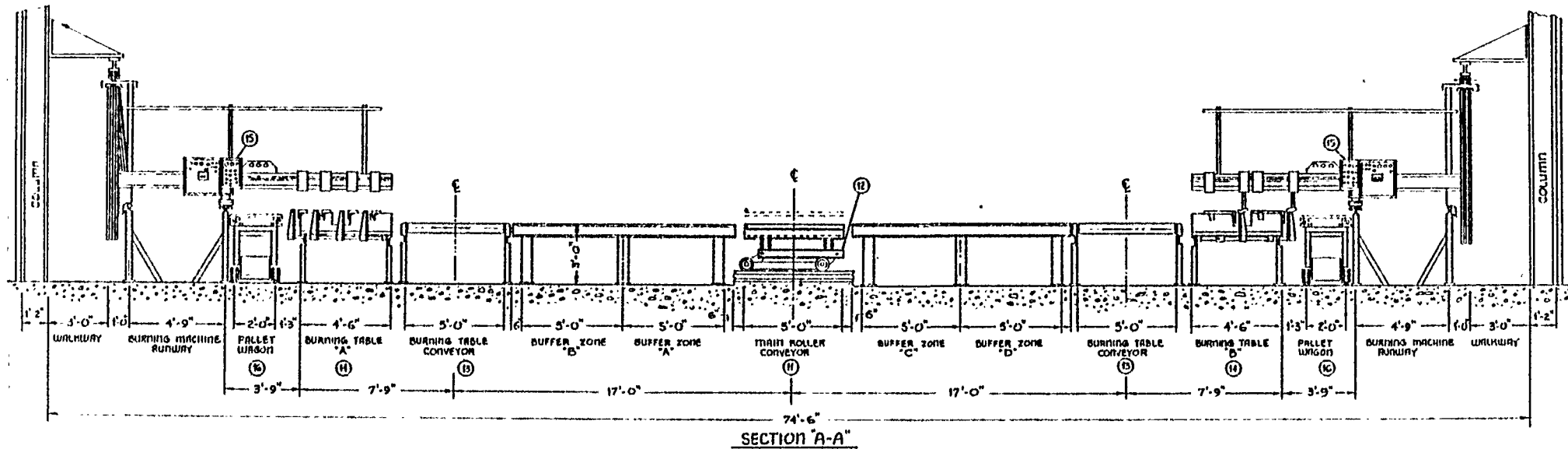
The following four sketches provide graphic perspective on the Semi-Automatic Beam Line as envisioned.

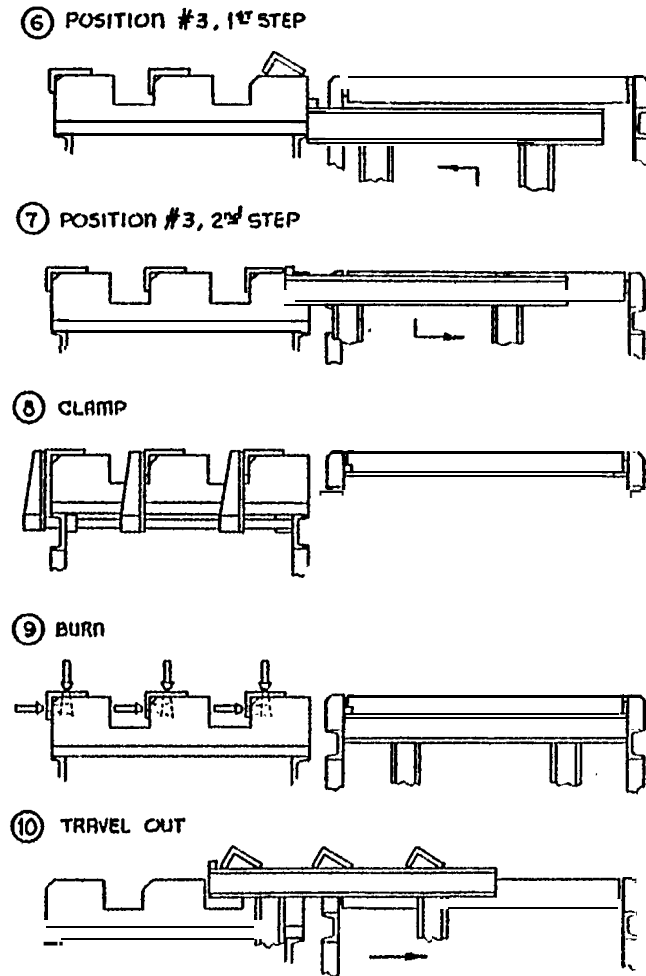
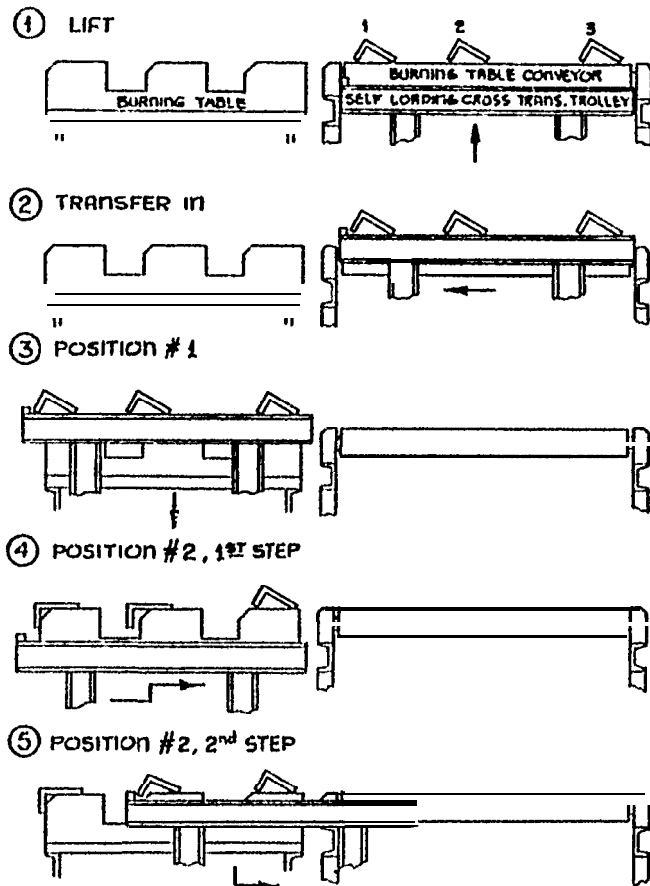
- The PLAN VIEW illustrates work station and production flow.
- The ELEVATION VIEW (Section A-A) illustrates the burning table and transfer system.
- SHAPE MANIPULATION shows step-by-step loading, positioning, clamping, burning, and unloading of the burning tables.
- PRODUCTION FLOW AND PRODUCTION RATE reflects, by process function, the flow of work for each work station to maintain the required production volume.



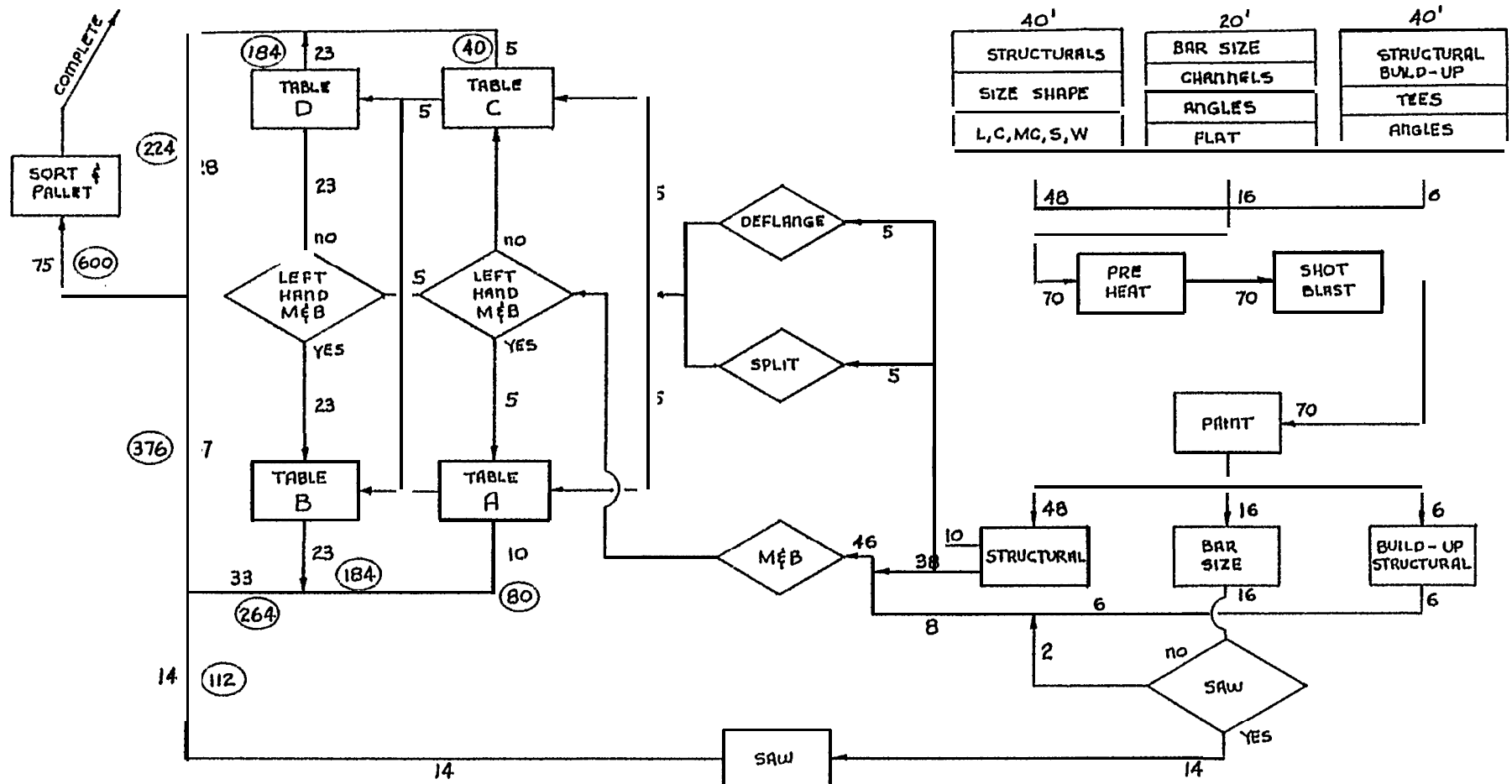
PLAN VIEW OF BEAM LINE PROPOSAL

| MARK | NAME OF SYSTEM & MACHINE | MARK | NAME OF SYSTEM & MACHINE |
|------|--------------------------|------|-----------------------------------|
| 1 | INFEED TRANSFER TABLE | 11 | MAIN ROLLER CONVEYOR |
| 2 | INFEED ROLLER CONVEYOR | 12 | TRANSFER SYSTEM |
| 3 | PRE-HEATER | 13 | BURNING TABLE CONVEYOR |
| 4 | SHOTBLAST MACHINE | 14 | BURNING TABLE |
| 5 | BLOW-OFF PLANT | 15 | CASE BURNING MACHINE |
| 6 | AUTOMATIC EXHAUST PLANT | 16 | PALLET WAGON |
| 7 | PAINT SPRAYER | 17 | OUTFEED CHAIN CONVEYOR |
| 8 | CARRYING CHAIN CONVEYOR | 18 | BAND SAW |
| 9 | OUTFEED ROLLER CONVEYOR | 19 | OUTFEED CONVEYOR W/ EIGHTH BRIDGE |
| 10 | TRANSFER TABLE | 20 | RACK FOR SHAPES |





TYPICAL SHAPE MANIPULATION
AND BURNING PROCESS



PRODUCTION FLOW AND RATE OF PROPOSED BEAM LINE

ASSUMPTIONS:-

- 1) SPLITTING STRUCTURES GENERATES 2 STOCK ITEMS, AND EACH OF THESE STOCK ITEMS WILL GENERATE A LEFT/RIGHT HAND OPERATION
- 2) EACH STOCK ITEM WILL GENERATE 8 COMPLETED PIECES.
- 3) QUANTITY OF COMPLETED ITEMS ARE INCIRCLED.
- 4) THE RATE OF PRODUCTION IS LEVEL LOADED SHOWING WHAT WOULD BE REQUIRED.
- 5) WORK STATION LOADING AND MANING FOR MAXIMUM UTILIZATION WILL BE MANAGEMENT JUDGEMENT.
- 6) "M & B" MEANS "MARK & BURN".

2.8 Equipment Specifications

Mark 1. Infeed Transfer Table. # Units: 1

| | | |
|-------------------------------------|---------|-----|
| Elevating trollies | | (6) |
| Length of trollies | 5' | |
| Lifting stroke | 4" | |
| Ht. off floor, table | 36" | |
| Ht. off floor, trolley down | 35" | |
| Ht. off floor, trolley up | 39" | |
| Trolley load capacity | 2 Tons | |
| System load capacity | 10 Tons | |
| Travel speed | 60 FPM | |
| Trolley track | | (6) |
| Length of track | 33' - | |
| Spacing of track | 5'6" | |
| | 8'3" | |
| | 11'0" | |
| Hydraulic drive system | | (1) |
| Hydraulic lifting cylinders | | (1) |
| Electrical controls: control system | | (1) |

Mark 2. Infeed Roller Conveyor. #Units:1

[Conveyor with drive. Can also be driven by surface treatment line to obtain synchronized speed.]

Rollers (18)

| | |
|-----------------|----------------------|
| Length | 46'6" |
| Width | 5' |
| Speed | 120 FPM; or variable |
| Roller spacing | 33" |
| Roller diameter | 5 1/2" |
| Ht. off floor | 36" |

Proximity detector [to stop conveyor when shapes reach pre-determined position] (1)

Electric gearmotor and clutch (1)

Mark 3. Preheater

The specified preheater (infra-red) has special high-output burners on upper and lower side for preheating of plates and beams. The controls will be in the main panel. Roller conveyor in preheater, and between preheater and shotblast machine, consists of: six (6) special design transport rollers, each complete with two (2) bearings; sprocket; and chain. Foundation is complete with chain guards. Typical operating parameters for the preheater include:

| <u>Operations</u> | | <u>Dimensions</u> | |
|---|------------------------|-------------------|-----------|
| Capacity: | 1 million BTU | Length of heater | 10' |
| Gas type: | Natural gas or propane | Width of passage | 5' |
| Gas consumption Max: | | Ht. of passage | 1'6" |
| 1100 cfh natural gas or 400 cfh propane | | Passage speed | 5 FPM (*) |
| Normal consumption: | | Temp. elevation | 32°-90°F |
| 60% of "maximum" figures above | | Max. water film | 1/64" |

Mark 4. Shotblast Machine

Dimensions

| | |
|--|-------------|
| Entrance dimensions for plates: | 5'X2" |
| Entrance dimensions for beams: | 3'3" X 1'6" |
| Conveyor height | 36" |
| Passage speed, variable | 2-10 FPM |
| Average passage speed for BSa 2 1/2 finish | 3-4 FPM |

Shotblasting Capability

| | |
|--------------------------|-------------|
| Plates: max. width | 5' |
| min. thickness | 1/4" |
| max. thickness | 2" |
| Beams: max. measurements | 3'3"X1'6" |
| min. transport length | 7' |
| max. transport wt | 760 lbs/ft. |

| <u>Operating Components</u> | <u>#of Units</u> |
|---|------------------|
| Turbines: 15 hp | 4 |
| Machine housing: 3/8" | 1 |
| Manganese steel lining: 1/8" | 1 |
| Manganese steel wear trip lining: 5/16" | 1 |
| Conveyor rollers [5 1/2"D x5'] | 4 |
| Conveyor rollers [5 1/2" Dx5'] with manganese steel rings | 4 |
| Power drive for roiler conveyor [2-10 FPM] | 1 |
| Passage tunnels [Each tunnel: 5 rubber curtains] | 2 |
| Abrasive return hopper with screw conveyor | 1 |
| Bucket elevator with gearmotor, speed control | 1 |
| Abrasive cleaner with strainer, air cleaning | 1 |
| Abrasive container | 1 |
| Abrasive control (electro-pneumatic) | 1 |
| Shotblast turbines [axial mechanical acceleration of the abrasive] | 4 |
| Servo motor (with pushbuttons & control-panel indicators) | 1 |
| Rotary switch (automatic abrasive control with impulse counters) | 1 |
| <u>Control Panel:</u> | 1 |
| with starters; fuses; cabline; turbine ammeters; hour counter; pushbuttons; indicator light; main switch. | |

Mark 5. Blow-off Plant

| <u>Component Parts</u> | <u>#</u> |
|-------------------------------|-----------------|
| Machine housing | 1 |
| Conveyor rollers | 3 |
| Cross-stream blow-off fan | 1 |
| Screw conveyor with gearmotor | 1 |

The total power for this unit is approx. 12 hp.

Mark 6. Automatic Exhaust Plant

Suitable for continuous service, this automatic exhaust plant has the following parameters of operation:

| | |
|------------------------------|------------------------|
| <u>Capacity:</u> | 7000 F ³ PM |
| <u>Motor:</u> | 10 hp, 450 rpm |
| <u>Filter Area</u> | 3000 ft. ² |
| <u>Dust Emission:</u> | 0.3mg/ft. ³ |

and the following major component parts:

| <u>Component Part</u> | <u>#</u> |
|---|-----------------|
| Filter housing with inspection doors | 1 |
| Foundation with dust collection hopper | 1 |
| Dust outlet valve | 1 |
| Filter cartridges [12 3/4 D x 22"] | 16 |
| Plastic dust bags | 150 |
| Ventilator with motor | 1 |
| Compressed air cleaning system: | 1 |
| Venturis: | 16 |
| Valves: | 8 |
| Program Switch: | 1 |
| Pressure-regulated oil/water separator: | 1 |

The plant also has ducting between machine and filter, including abrasive separator.

Mark 7. Airless Automatic Paint Sprayer

° Fully automatic length and width control for plates, profiles.

° Passage speed, maximum.: 10 FPM

° Operating components are as follows:

| <u>Component Part</u> | <u># of Units</u> |
|--|-------------------|
| Housing | 1 |
| Fans with motors | 2 |
| Bridges for spray guns | 2 |
| Power drive for bridges | 1 |
| Spray guns (airless) | 4 |
| Paint pump (airless) | 1 |
| Control systems (contact-free operation) | 2 |
| Control panel | 1 |
| Paint tank, 32 gal. 0.25 KW electric mixer | 1 |
| Thinner tank, 32 gal., with foundation | 1 |

° Roller conveyor in paint sprayer and between paint sprayer and shotblast machine is complete with:

“o 5 transport rollers (special)

00 1 foundation with chain guards (special)

Mark 8. Carrying Chain Transport

This item of equipment is complete with chain drive from the roller conveyor.

Its dimensions are:

| | |
|----------------|------------|
| Length: | 20' |
| Width | 5' |
| Slat distance: | approx. 8" |

Conveyor with drive. Can also be driven by surface treatment line to obtain synchronized speed.

| | |
|---------------|-----------------------|
| Length | 46' |
| Width | 5' |
| Ht. off floor | 36" |
| Speed | 120 FPM (or variable) |

| | |
|-------------------|--------|
| Number of rollers | 18 |
| Roller spacing | 33" |
| Roller diameter | 5 1/2" |

| Other Component Parts: | # of Units |
|--|------------|
| °0 Proximity Detector to stop conveyor when shapes reach a pre-determined position | 2 |
| “o Conveyor Bumper | 1 |
| 00 Electric Gearmotor and clutch | 1 |
| 00 Alternate clutch (for coupling to surface treatment conveyor drive) | 1 |

Mark 10. Transfer Table. #Units: 1**Elevating trollies** (6)

| | |
|-----------------------------|-----|
| Length | 5' |
| Lifting stroke | 4" |
| Ht. off floor, table | 36" |
| Ht. off floor, trolley down | 35" |
| Ht. off floor, trolley up | 39" |

Trolley track (6)

| | |
|---------|------------------|
| Length | 43' |
| Spacing | 5'6" 9'3" 11' 0" |

Trolley load capacity 2 Tons

System load capacity 10 Tons

Travel speed 60 FPM

Hydraulic drive system (1)**Hydraulic lifting cylinder** (1)**Electrical controls: control system** (1)**Mark 11- Main Roller Conveyor. # Units: 1****Rollers** (72)

| | |
|-----------------|---------|
| Length | 196' |
| Width | 5' |
| Ht. off floor | 36" |
| Speed | 100 FPM |
| Roller diameter | 5½" |
| Roller spacing | 33" |

Conveyor bumper (1)**Proximity detector** (3)

[To stop conveyor when shapes
reach pre-determined positions]

Electrical controls: control system (1)

| <u>Mark 12. Transfer System. # Units: 2</u> | | |
|---|-------|----------|
| Elevating trollies | | 7 |
| Length | 5' | |
| Lifting stroke | 9" | |
| Ht. off floor, down | 33" | |
| Ht. off floor, position ht. | 41½" | |
| Ht. off floor, travel ht. | 43" | |
| Trolley track | | 7 |
| Length | 50'6" | |
| Spacing | 5'6" | |
| Hydraulic drive system | | 1 |
| Hydraulic lifting cylinder | | 1 |
| Electrical controls: control system | | 1 |

| <u>Mark 13. Burning Table Conveyors. # Units: 2</u> | | |
|--|---------|-----------|
| Conveyor with drive | | 1 |
| Length | 84' | |
| Width | | |
| Ht. off floor | 100 FPM | |
| Speed | | |
| Rollers | | 30 |
| Roller spacing | 33" | |
| Roller diameter | 5½" | |
| Conveyor bumper | | 1 |
| Proximity detectors | | 1 |
| To stop conveyor when shapes reach pre-determined position | | |
| Electrical controls: control system | | 1 |

| <u>Mark 14. Burning Table. # Units: 4</u> | | |
|---|-------|----------|
| Sectional burning table with replace-able ribs for holding up to 4 shapes | | 1 |
| Overall length | 40' | |
| Width | 4' 6" | |
| Rib spacing | 1' | |
| Ht. off floor | 42" | |
| # full sections | 7 | |
| # half sections | 1 | |
| Length full sections | 50" | |
| Length half sections | 12" | |
| Hydraulically-operated shape clamping system for straightening and holding shapes during marking and burning | | 1 |
| Number clamping lines | 5 | |
| Numer clamps per line | 4 | |

Mark 15. CNC Burning Machines. # Units: 2

Machine carriage and cantilever arm of double beam construction.

| | |
|------------------------|-------|
| °Track gauge | 10' |
| °Carriage length | 7'7" |
| °Overall width | 25'2" |
| o Working width (max.) | 10' |

Machine drive, double side in longitudinal direction, for use with NC or optical controls, including permanent magnet DC servo motors with synchro feedback.

| | |
|---|---|
| °servo motors (5): | |
| o Longitudinal-drive motors (X direction) | 2 |
| °Transverse-drive motors (Y direction) | 1 |
| °Vertical-drive motors (Z direction) | 2 |

Machine control system, with electronic synchronization to control torch motion in either X-Y or X-Z planes.

| | |
|----------------------------|------------|
| °Cutting speed: (variable) | 2 - 150ipm |
|----------------------------|------------|

Torch Suspensions.

| | |
|--|------|
| ° Torch holders designed to profile-cut beams in the X-Y plane only: | 2 |
| ° Torch holders designed to profile-cut beams in either the X-Y or X-Z planes: | 2 |
| ° Motorized vertical travel | 21½" |
| ° Manual vertical travel: | 6" |
| ° Torch holder width: | 15" |

Hose and cable suspension system for 89' of machine travel.

| | |
|-------------------|------|
| °Length of hoses: | 200' |
|-------------------|------|

Machine-mounted gas system, with gas controls including pilot regulators mounted on the control panel to control high-capacity gas regulators mounted on the inlet side of gas manifold. (1)

- ° 1 cutting oxygen 1
- ° 1 preheat oxygen 1 a
- ° 1 fuel gas 1
- ° Solenoid valves for activating gas system 3
- ° Pressure gauges 3
- ° Adjustable throttle valve: [provides range of ease-on rates for cutting oxygen during the pierce cycle]. 1
- ° Gas manifold for four (4) torch suspension. 1 1

Track system. (1)

- ° Length of track 96'
- ° Machine travel 89'

Remote torch ignition system for 89' of machine travel. (1)

- ° Number of torch igniters

Marking units, capable of making a single punch mark or a series of punch marks, one per torch suspension. (1)

[Note: The marking units are capable of marking in X-Y only.]

Microprocessor-based, programmable computer numerical control (CNC) with direct numerical control (DNC) capability. (1)
involved in this capability should be:

- ° Program Read-Out Memory (PROM)
- ° Manual Data Input (MDI)
- ° Random Access Memory (RAM)
- ° Tape Reader
- ° Parts Library (including alpha-numeric characters)
- ° Length measuring system
- ° Interface.

The Interface allows direct numerical control from the computer center. The microprocessor features microcomputer control for each axis. Motor control is accomplished by the pulse-width modulation technique.

Mark 16. Pallet Wagon. # Units:2

Wagon with elevating carriage and flanged wheels. (1)

Designed to carry a single standard pallet.

Length: 3'
Width: 3'
Ht. lowered: 31"

Pushbutton controls. For sending wagon to palletizing area and returning wagon to appropriate work station. (1)

Mark 17. Outfeed Chain Conveyor. # Units: 1

Parallel chain conveyors. With elevating sector overlapping roller conveyor (Mark 11). (7)

Length of elevating sector: 6'
Length of fixed sector: 18'9"
Ht. off floor, fixed sector: 36"
Load capacity per line: 2 Tons
System load capacity: 10 Tons
Travel speed: 60 FPM

Common electric drive unit for elevating and fixed sector.

Pneumatic lifting cylinders for elevating sector, electrical control system, and controls.

Proximity detector to stop conveyor when conveyor is full. (1)

Load stops (bumpers) to prevent load falling off at end of conveyor. (1)
per line

Automatic indexing feature for off-loading roller conveyor when load reaches pre-determined position on roller conveyor.

Mark 18. Band Saw. #Units: 1Capacity

| | |
|------------------|--|
| Nominal: | 18" x 20" rectangles 18" rounds |
| Blade at 45° (L) | 18" x 11 1/2" rectangles 13 1/2" rounds |
| Blade at 45° (R) | 18" x 13 1/2" rectangles 13 1/2" rounds |

Speed

Varies greatly.
Hydraulically controlled.
60-400 FPM.

Component PartsTilting Column.

For miter cutting. L & R of vertical. Built-in protractor.

Upper Blade Arm Guide.

Hydraulically positioned.

Vise. (Hydraulically operated). 7"H x 12" W

Coolant System.

Built-in. Manual crack-type chip conveyor, -chip pan.

Flushing HoseMotors.

Main drive 10 hp
Coolant pump 1/4 hp

Controls.

Transformer provides low-voltage controls: (115 volts & 60 Hz).

Supplementary Equipment.

Hydraulically-operated Work-Lift-Roller on L side
machine bed.

Hydraulically-operated Work-Lift-Roller on R side
'machine bed.

Second Machine Vise.

Complete

Standard jaws 7"h x 12' w

Hydraulic Hold-Downs.

~~"Nest clamps"~~ for vertical clamping of structural
shapes or multiple bar work.

Installed on either side of blade.

Capacity 18" horizontal 9 1/2" vertical

Aligning Guides .

Vertical roller type.

To align incoming work.

Mark 19. Outfeed Roller Conveyor. # Units: 1

Live Roller Table with hydraulic gauge. (1)

10' 0" long. Hydraulic dead stop. Tilting type gauge mounted on rail fastened to front side of roller table. Electronic digital readout.

Extension Live Roller Table. (1)

10' 0" long, with gauging. Equipped with gauge rail.

Work Ejector. (1)

10'0" long. 4" x 4" ejector bar. Hydraulically powered from operator's station to move (eject) work pieces laterally to receiving rack.

Flush Plates. (1)

To fill space between work rollers on all table sections; to prevent short pieces from falling between rollers; a set to fill all spaces on first table section is included.

Mark 20. Rack for Shapes

Number of Rack units: (7)

| | |
|--------------------|-----|
| Length | 3' |
| Ht., conveyor side | 36" |
| Ht., opposite side | 16" |

Steel frames bolted to floor.

End date for shapes at end of each rack.

Index to SECTION THREE, which follows:

- 3.1 Introductory Note**
- 3.2 Computer-Aided Drawing System (CAD)**
- 3.3 Beam Line Management System (BLMS)**
- 3.4 Computer Numerical Control (CNC)**
- 3.5 Data Requirements**
- 3.6 Standard Configurations**

SECTION THREE

COMPUTER SOFTWARE FOR THE SEMI-AUTOMATIC BEAM LINE

3.1 Introductory Note

This section presents some requirements for the computer software that must be developed and made available to support the Semi-Automatic Beam Line. The system that is envisioned will process the required data; and, through an interface, drive the shop machines (CNC/DNC): optimizing beam cutting to minimize scrap and maximize shop load for efficiency

3.2 Computer-Aided Drawing System (CAD)

The computer-aided drawing system will create daily the Detail Drawings. These drawings will be made with the aid of the Computer Graphic Display System that will be modified to meet a particular yard's needs. The graphic system will utilize a master file of Standard Details that will be passed to the Beam Line Management System: which in turn will feed back information to CAD, for the actual routing and printing of the Detail Drawings. The primary objective of CAD is to offset any major increase in the engineering staff necessary to provide the drawings and other data in a timely manner.

3.3 Beam Line Management System (BLMS)

The purpose of the BLMS is to aid in the, scheduling and operations of the shop. To accomplish those purposes, two major inputs must be provided. The first of these is the file of Detail Drawings that will be produced by CAD. The second major input is the Master Schedule (Beam processes only). The BLMS will use these two major sources of input, and other preloaded system master files, to schedule work through the shop. The other system master files will contain data on each of the machines in the shop: e.g., load capacity; maximum beam size; and other special information regarding each item of equipment. This set of files will also contain a catalog of each Standard that is used by the shop.

The BLMS will also produce information on daily material requirements; assembly marking information; final disposition of completed work; and a Shop Status Report. One objective of BLMS is to allow for the concurrent preparation of:

- °Shop Production Schedules
- °Material Schedule Requirements
- °Work Station Loadings
- and" more.

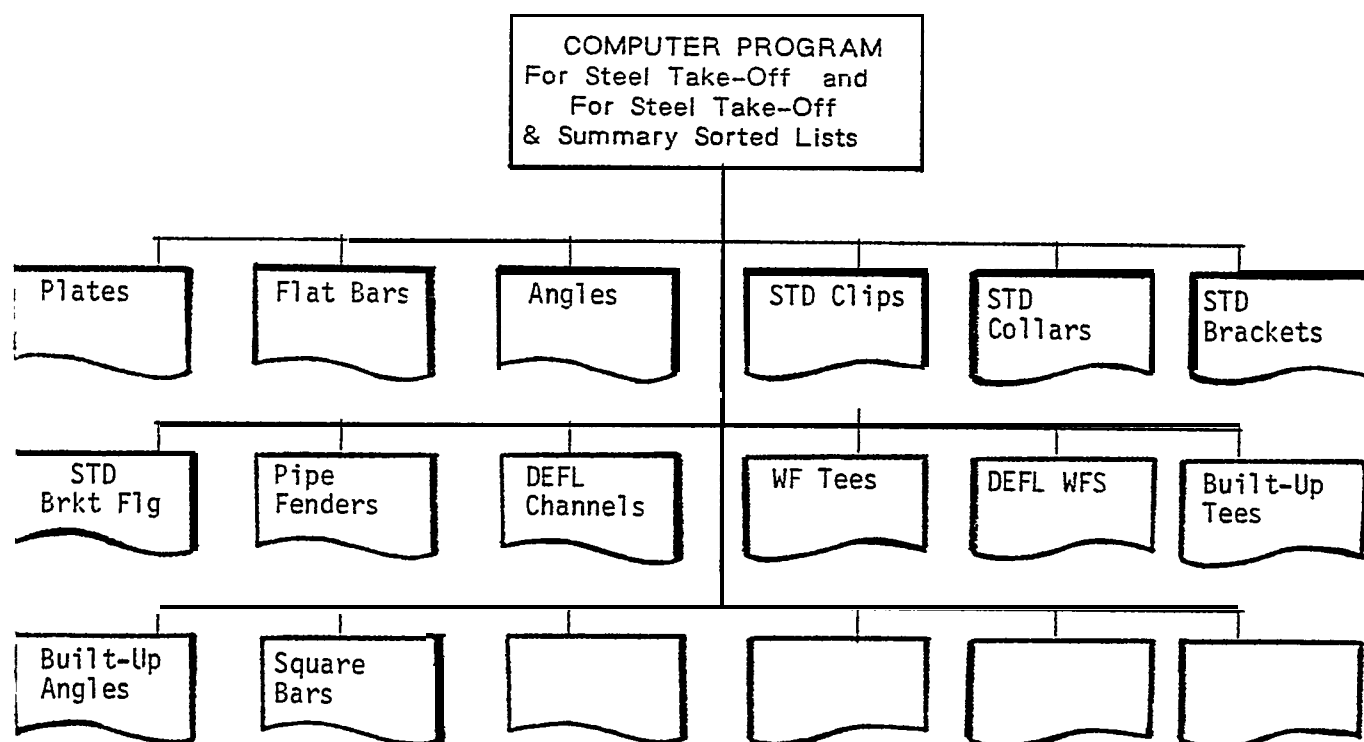
Another objective of the BLMS is to control the storage, retrieval, and site delivery of palletized completed work pieces which have been produced in the shop.

3.4 Computer Numerical Control (CNC)

The machine control could be a microprocessor-based, programmable Computer Numerical Control (CNC) with Direct Numerical Control (DNC) capability through two interfaces. Although capable of local direction, the normal mode would be through a direct link to the appropriate computer center.

3.5 Data Requirements

We envision a computer program for Steel Take-Off and Summary Sorted Lists:

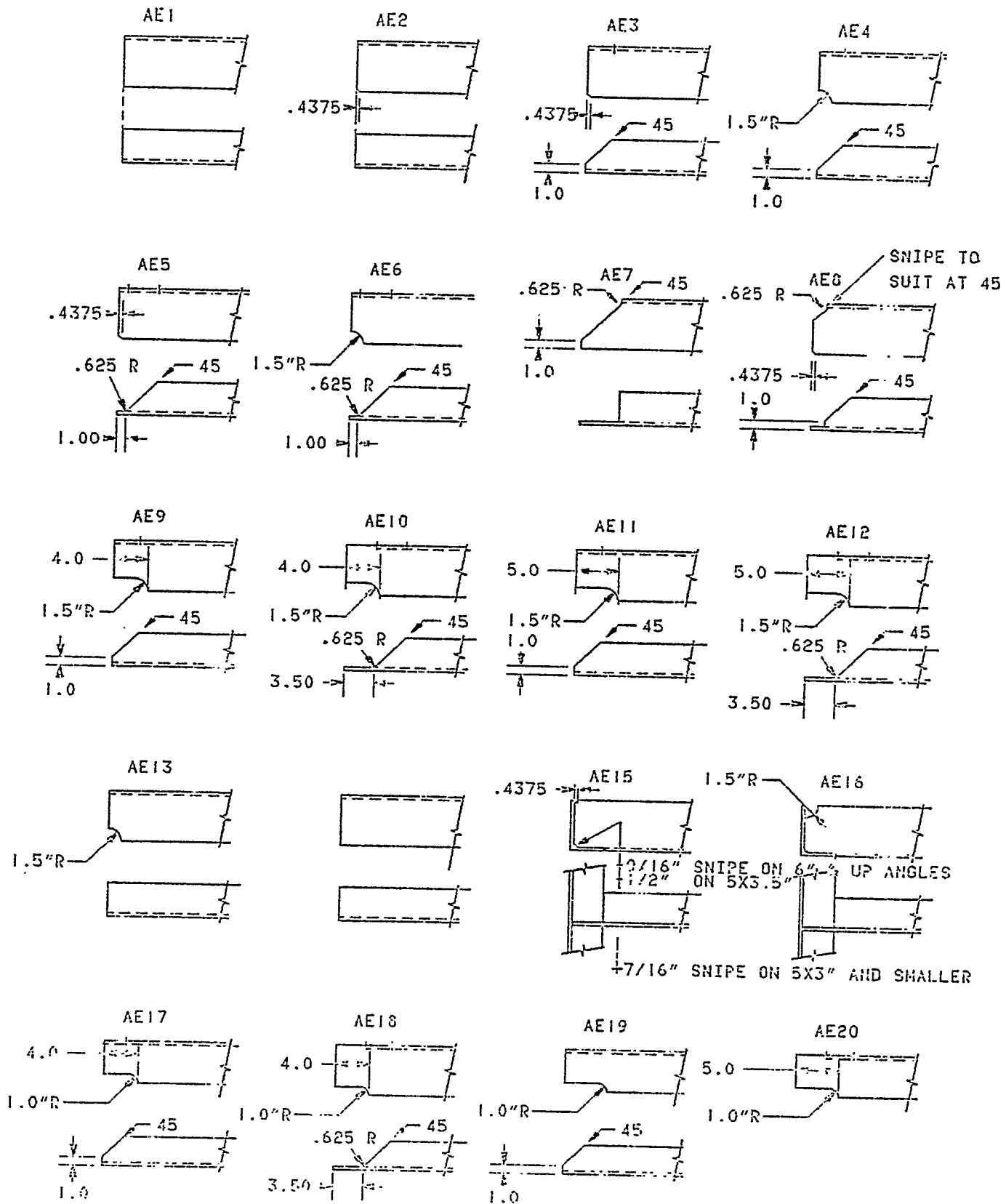


which would include the following typical data: Basic Angle End Cut Configurations. Basic Tee End Cut Configurations. Basic Flat Bar End Cut Configurations. Typical Flat Bar Details. Water Stops. Typical CT & CL for 6 x 3 1/2 Angle. Rationalization on Angle Cut Out Nomenclature. Additionally, edge preparation data when applicable should be included. The computer will process the required data and through the interface procedure run the Beam. Line machines as directed in schedule order.

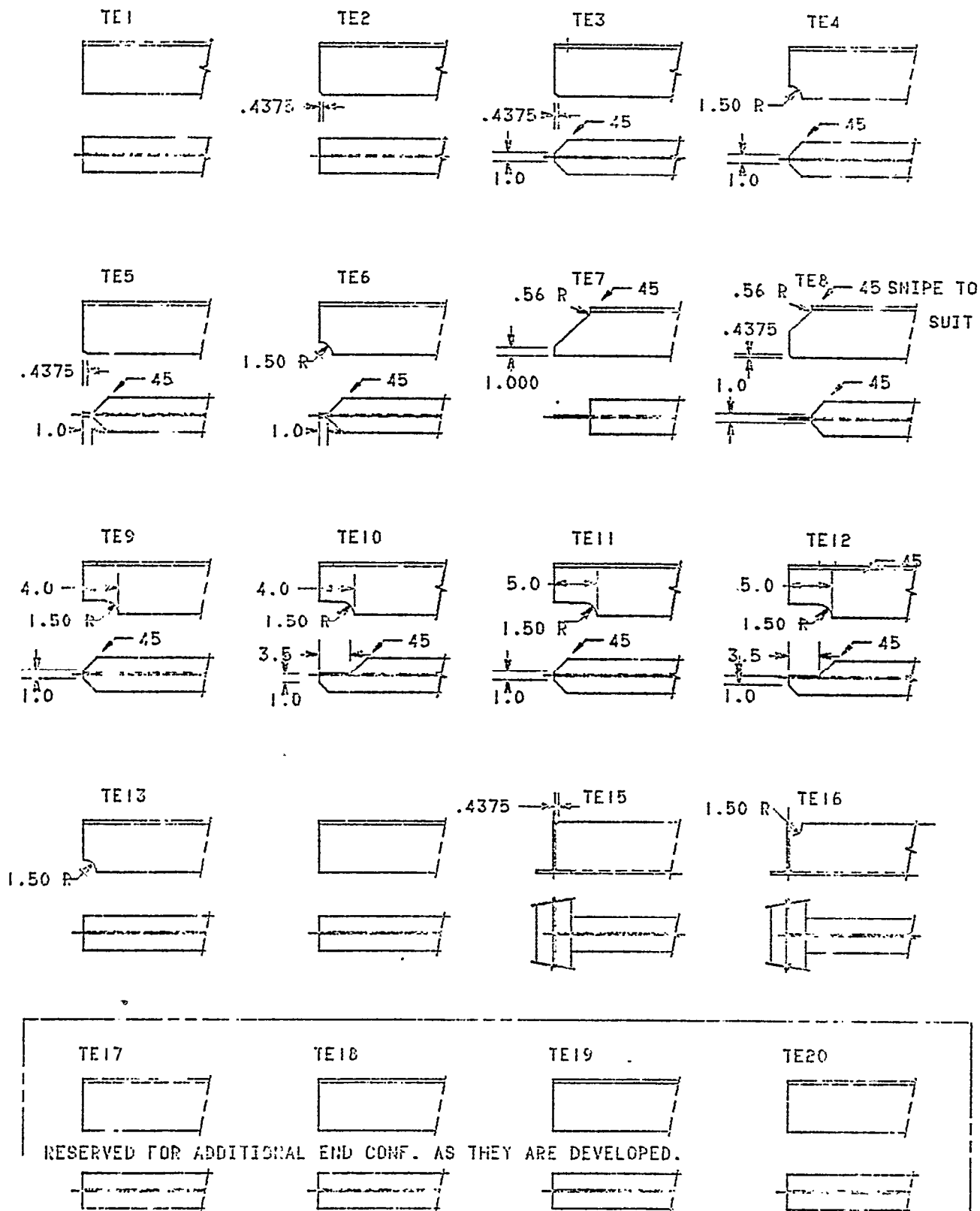
3.6 Standard Configurations

Samples of standard configurations mentioned follow on the next pages.

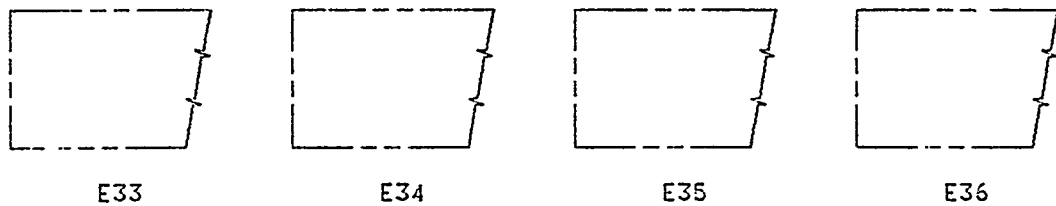
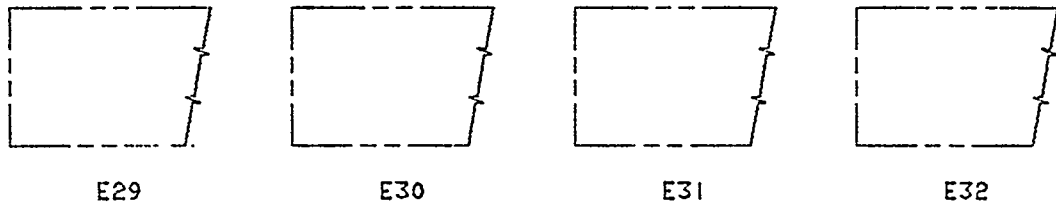
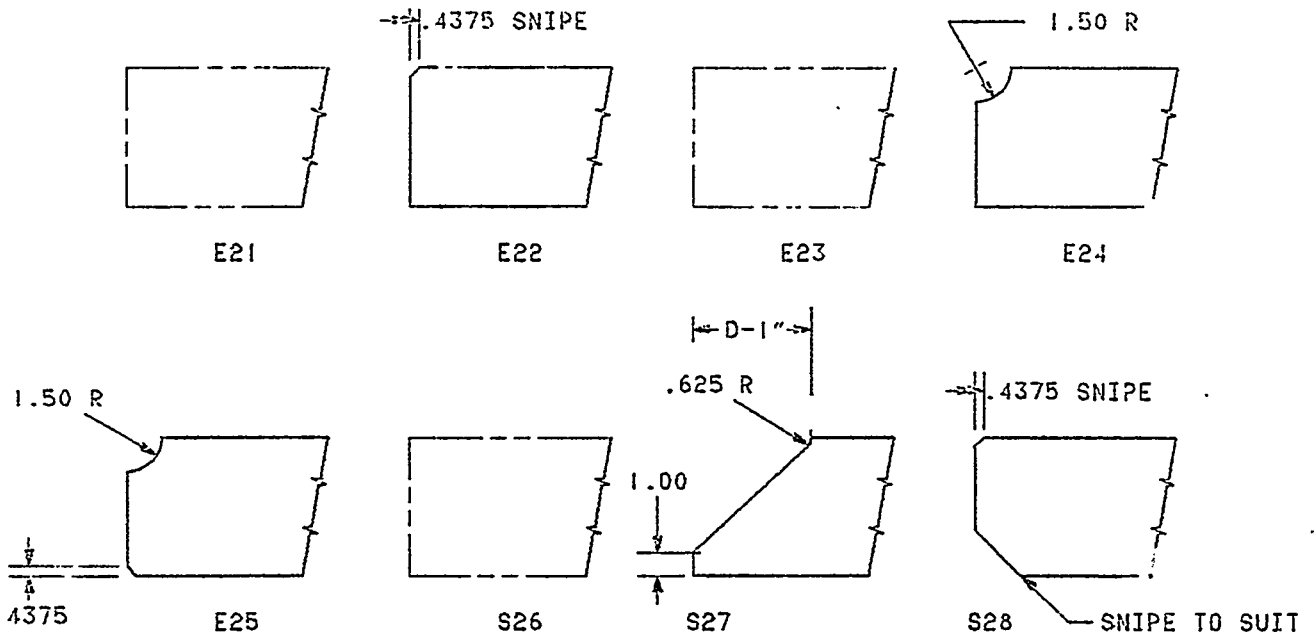
BASIC ANGLE END CUT CONFIGURATIONS



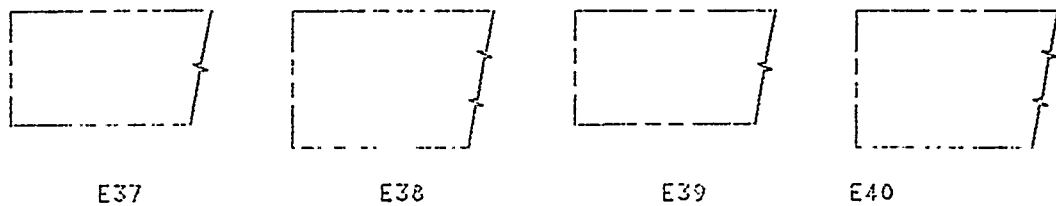
BASIC TEE END CUT CONFIGURATIONS

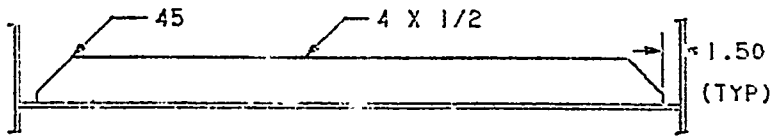
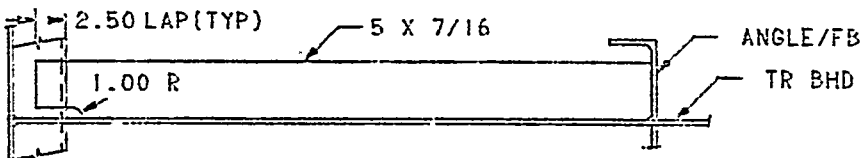
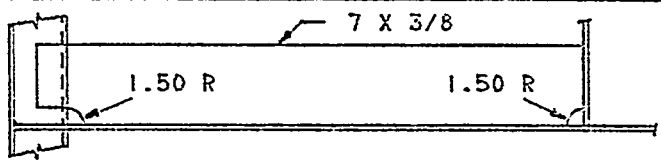
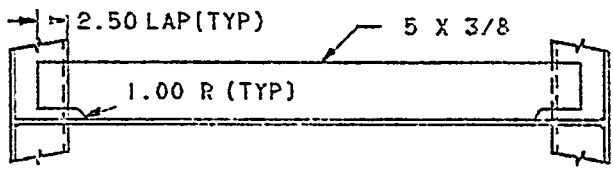
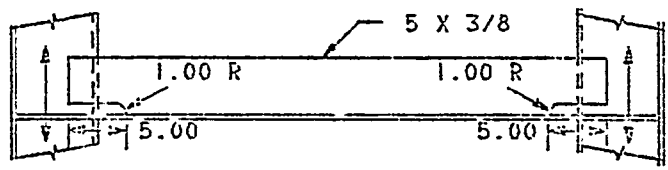
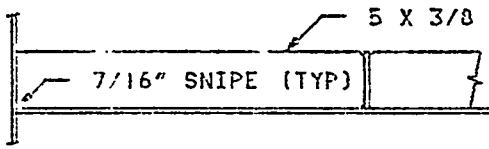
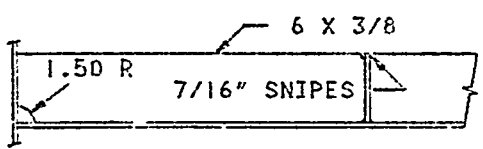
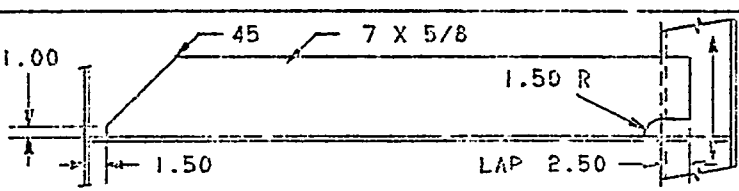
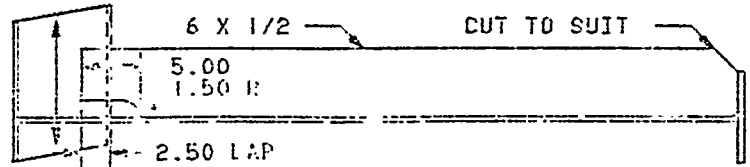


BASIC FLAT BAR END CUT CONFIGURATIONS

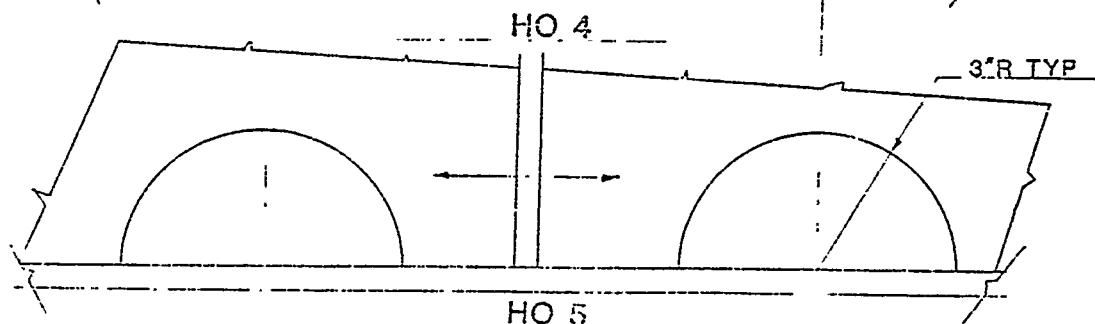
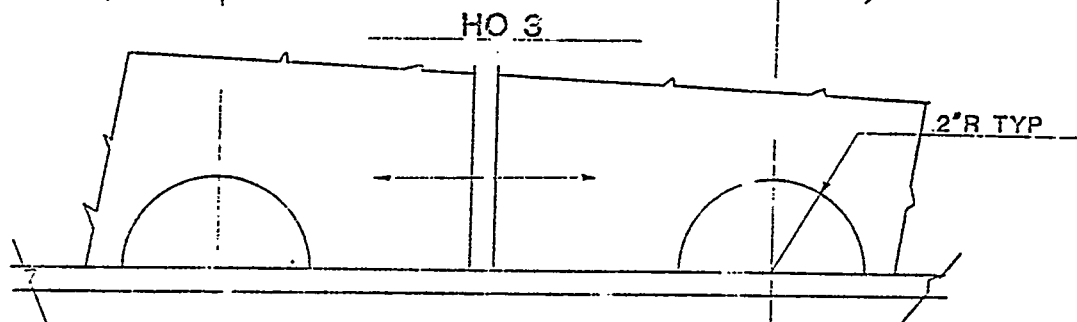
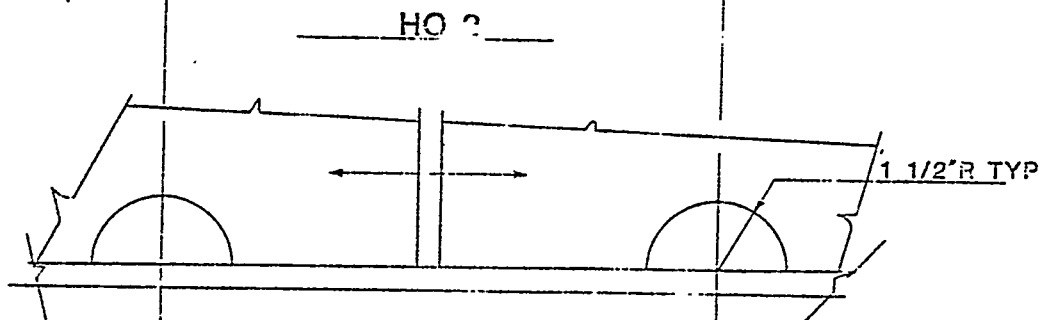
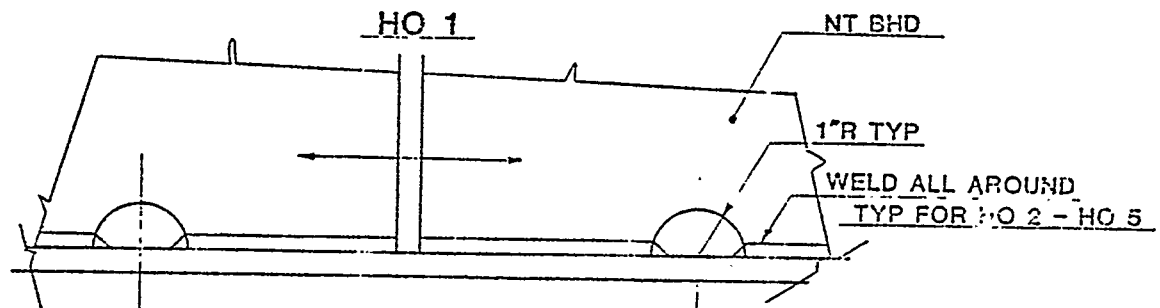
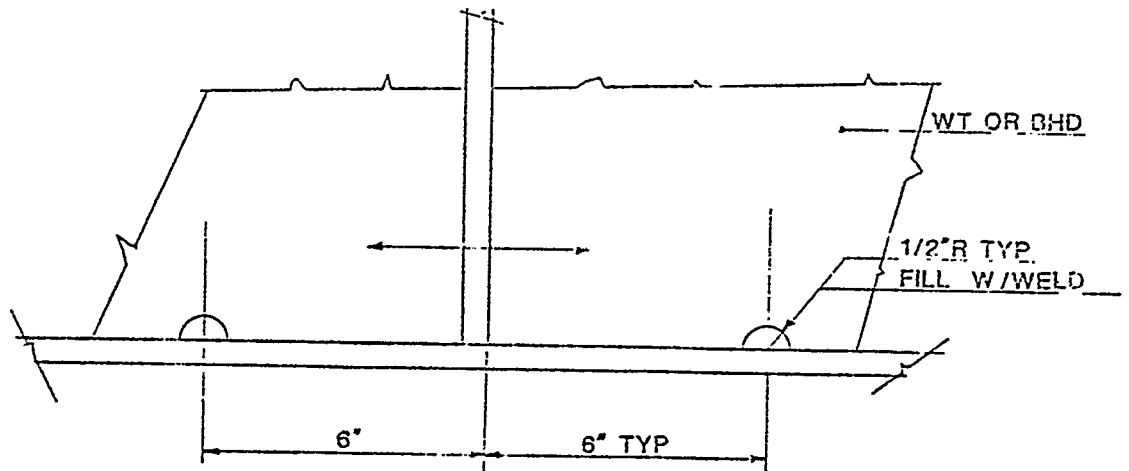


NOTE: FOR THE ASSIGNMENT OF END CUT NOS. VIEW OF THE FB
IS TAKEN WITH THE WELDED SIDE DOWN

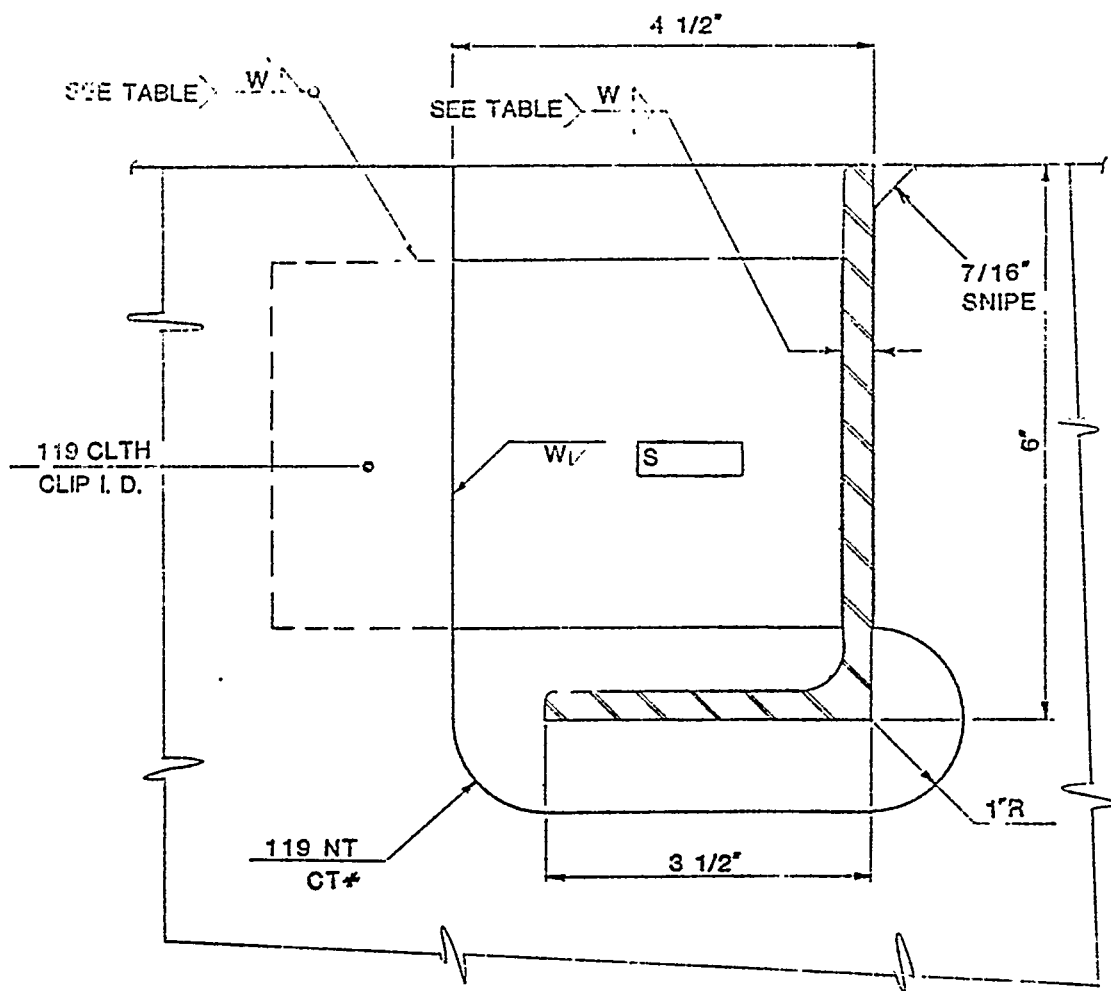


| END COMB | DETAILS AND DRAWING NOTATIONS |
|-------------|--|
| E7/E7 |  |
| E17/E2 |  |
| E9/E4 |  |
| E17/E17 |  |
| E19/E19 |  |
| E2/E3 |  |
| E4/E3 |  |
| E7/E9 |  |
| E11/E8 |  |

WATER STOPS



TYPICAL CT & CL FOR 6 x 3 1/2 ANGLE

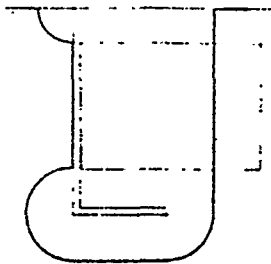


| CLIP TABLE | | | | |
|------------|------|-----------|------|-------|
| TH | | STD PC MK | W | SIZE |
| 16ths | Inch | | | |
| 4 | 1/4 | S025 | 3/16 | 6 x 4 |
| 5 | 5/16 | S035 | 3/16 | |
| 6 | 3/8 | S042 | 1/4 | |
| 7 | 7/16 | S052 | 1/4 | |
| 8 | 1/2 | S062 | 5/16 | |
| 10 | 3/4 | S090 | 3/8 | |
| 12 | 3/4 | S091 | 3/8 | |

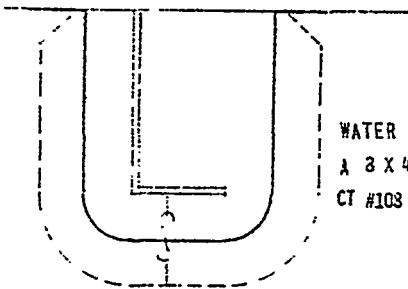
RATIONALIZATION ON ANGLE CUT-OUT NOMENCLATURE

CUT-OUTS RATIONALIZATION

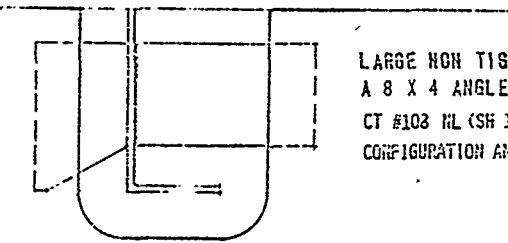
CUT-OUTS FOR STRUCTURAL MEMBERS ARE STANDARDIZED IN THIS BOOKLET ACCORDING TO TYPE AND ARE ASSIGNED A DESIGNATION NUMBER IN ACCORDANCE WITH THE BELOW RATIONALIZATION:



NON TIGHT TYPE "NT" CUT-OUT WHICH IS ASSIGNED A SERIES 100 NO SUCH AS "101" FOR
A 9 X 4 ANGLE PENETRATION.
CT #101 NT (SH 22) DWS. NO. 101 NT



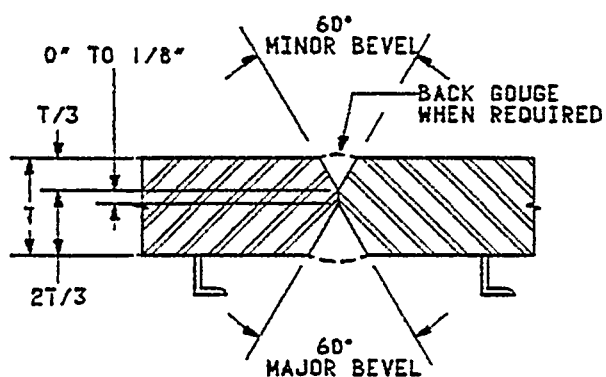
WATER OR OIL TIGHT TYPE "WT" CUT-OUT WHICH IS ASSIGNED A SERIES 100 NO FOR
A 8 X 4 X 3/4 ANGLE PENETRATION.
CT #103 WT (SH 47) DWS. NO. 109 WT



LARGE NON TIGHT TYPE "NL" CUT-OUT WHICH IS ALSO ASSIGNED NO "103" FOR
A 8 X 4 ANGLE PENETRATION.
CT #108 NL (SH 119) DWS. NO. 108 NL
CONFIGURATION AND SIZE OF 108 WT AND 108 NL ARE THE SAME

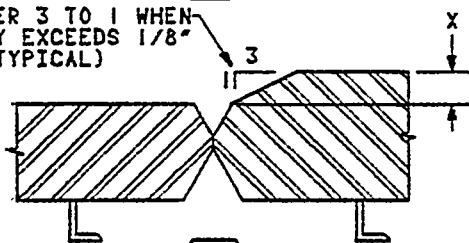
| ASSIGNMENT OF ENGR CT NOS. | | | | | | | | | |
|----------------------------|--------|--------|--------|---------------|--------|--------|--------|--|--|
| ANGLES | | | ANGLES | | | | | | |
| 9 X 4 | 101 NT | 101 WT | 101 NL | 3 1/2 X 3 | 137 NT | 137 WT | 137 NL | | |
| 8 X 6 | 104 NT | 104 WT | 104 NL | 3 1/2 X 2 1/2 | 140 NT | 140 WT | 140 NL | | |
| 8 X 4 | 108 NT | 108 WT | 108 NL | 8 X 8 | 151 NT | 151 WT | 151 NL | | |
| 7 X 4 | 112 NT | 112 WT | 112 NL | 6 X 6 | 157 NT | 157 WT | 157 NL | | |
| 6 X 4 | 115 NT | 115 WT | 115 NL | 5 X 5 | 163 NT | 163 WT | 163 NL | | |
| 6 X 3 1/2 | 119 NT | 119 WT | 119 NL | 4 X 4 | 168 NT | 168 WT | 168 NL | | |
| 5 X 3 1/2 | 121 NT | 121 WT | 121 NL | 3 1/2 X 3 1/2 | 174 NT | 174 WT | 174 NL | | |
| 5 X 3 | 125 NT | 125 WT | 125 NL | | | | | | |
| 4 X 3 1/2 | 129 NT | 129 WT | 129 NL | | | | | | |
| 4 X 3 | 133 NT | 133 WT | 133 NL | | | | | | |

STANDARD EDGE PREP (WJ 13)

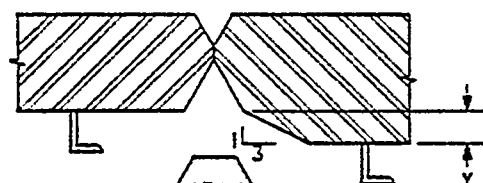


13A

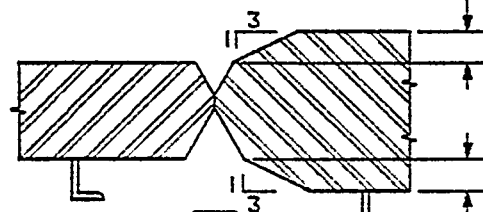
CHAMFER 3 TO 1 WHEN
X OR Y EXCEEDS 1/8"
(TYPICAL)



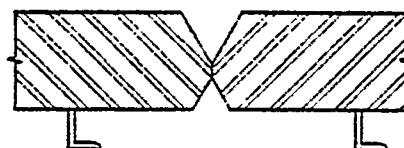
13AX



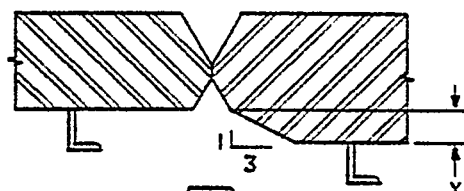
13AY



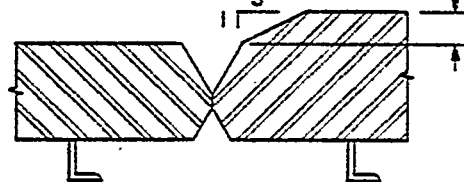
13AXY



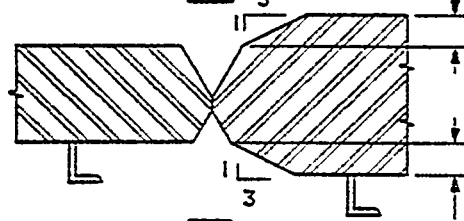
13B



13BX



13BY



13BXY

SAW = SUBMERGED ARC WELDING
FCAW = FLUX CORE ARC WELDING

A = BEVEL STIFFENER SIDE
B = BEVEL OPPOSITE STIFFENER SIDE

X = CHAMFER OPPOSITE BEVEL SIDE
Y = CHAMFER BEVEL SIDE

T = 1/2" MINIMUM TO 1 1/2" MAXIMUM

WELD JOINT DESIGN 13

FULL AUTOMATIC FCAW AND/OR SAW,
SEMI-AUTOMATIC OR FULL AUTOMATIC FCAW

Index to SECTION FOUR, which follows:

- 4.1 Introductory Note**
- 4.2 Machine-Computer Interface**
- 4.3 Robotics Use: Cutting Process**
- 4.4 Accuracy Control**
- 4.5 Automatic Unload: Small Parts**

SECTION FOUR

ADVANCED RESEARCH AND DEVELOPMENT

4.1 Introductory Note

During the course of this study, areas which offer good potential for significant productivity gains were observed: and were recommended for this section, which suggests selected topics as meriting additional investigation.

4.2 Machine-Computer Interface

Presently, substantial emphasis is being directed toward CAD/CAM in our industry. From a facilities point of view, computer-driven machinery or computer-driven systems require research regarding interface. There are mediums available that provide computer-machine communication. Additional research is desirable in the matter of compatibility requirements of the machine controls, systems, interface, and main frame computer.

4.3 Robotics Use: Cutting Process

Application of robotics to the cutting process has potential for cost-effectiveness. This particular methodology would see a desirable application in a use such as Accuracy Control.

4.4 Accuracy Control

Here, the concern is ability to maintain repetitive accuracy (or predictability) at process points where such predictability is needed: as, for example, with burning gases. Burning head proximity calibration maintainability matched with burning speeds and burning gas temperature (BTU/Cf) is desirable.

4.5 Automatic Unload: Small Parts

Cost-effective application of devices for unloading small parts from machines which are part of an automated system is desirable. One necessity at this time: determination of means for efficient automatic unloading of machines (small parts).

Index to SECTION FIVE, which follows:

- 5.1 Shipyard Survey**
- 5.2 Beam-Line Survey**
- 5.3 Beam-Line Equipment
Manufacturers/Suppliers**

SECTION FIVE

SEMI-AUTOMATIC BEAM LINE FEASIBILITY STUDY: PROJECT RESOURCES

5.1 Shipyard Survey

To obtain representative information on current Beam Line facilities and processes, on-site beam fabrication facilities were surveyed at the following shipyards:

Domestic

- ° Bath Iron Works
Bath, Maine
- ° Ingalls Shipbuilding (Division of Litton Industries)
Pascagoula, Mississippi
- ° National Steel and Shipbuilding Company
San Diego, California
- ° Sun Ship, Incorporated
Philadelphia, Pennsylvania

Foreign

- Horten Shipyard - Oslo, Norway
- ° Uddevalla (Shipyard) - Gothenberg, Sweden

5.2 Beam Line Survey

Ship producers of major significance generally considered to be leaders in Beam Line processes were consulted:

- ° Bath Iron Works - Bath, Maine
- ° Horten Shipyard - Oslo, Norway
- ° Sun Ship Incorporated - Philadelphia, Pennsylvania
- ° Uddevalla (Shipyard) - Gothenberg, Sweden

5.3 Beam Line Equipment Manufacturers/Suppliers

To investigate the latest available technology for beam fabricating procedures; as well as the feasibility of use of specialized semi-automated equipment to aid beam line processes in today's shipbuilding; and to identify potential interest in follow-on development, installation and implementation of an advanced Beam Line facility, the following equipment manufacturers and suppliers were consulted during the course of this project:

- ° AIRCO Products - King of Prussia, Pennsylvania
- ° ESAB A.B. Engineering - Houston, Texas
- ° Ervin Industries, Incorporated - Ann Arbor, Michigan
- ° LERCO, Incorporated - Louisville, Kentucky
- ° Messer Greishiem Company - Menomonee, Wisconsin
- ° Oxytechnik - Frankfurt, Germany
- ° Total Transportation Systems, Incorporated
Newport News, Virginia
- ° W. C. Whitney Company - Rockford, Illinois

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